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Michigan Technician Need Study. The Present and Projected Demand for Technically Trained People in Michigan.

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This study undertakes to determine (1) the extent of crucial manpower shortages in Michigan by technical area and skill, by the areas of occupation or industry, and whether these shortages will decrease or increase over the next few years, and (2) the opportunities for technical education now available or necessary to assure Michigan industry and business an adequate supply of trained manpower. Firms to be included in the study were selected on a non-random basis to obtain maximum geographical, industrial, and labor force coverage. Data represent 1,218 firms from private industry which includes 49 percent of the Michigan wage and salary workers as of January 1966. There is general agreement among employers that the need for technicians will increase substantially during the next few years and that there is a present unmet need in virtually every classification. The major source of technicians is the up-grading of existing employees. Only recently have employers recognized community colleges and technical institutes as sources of technicians; however, the enrollments here will not meet employers' manpower needs. Nine recommendations are given. For a summary report see VT 004 617. (EM)

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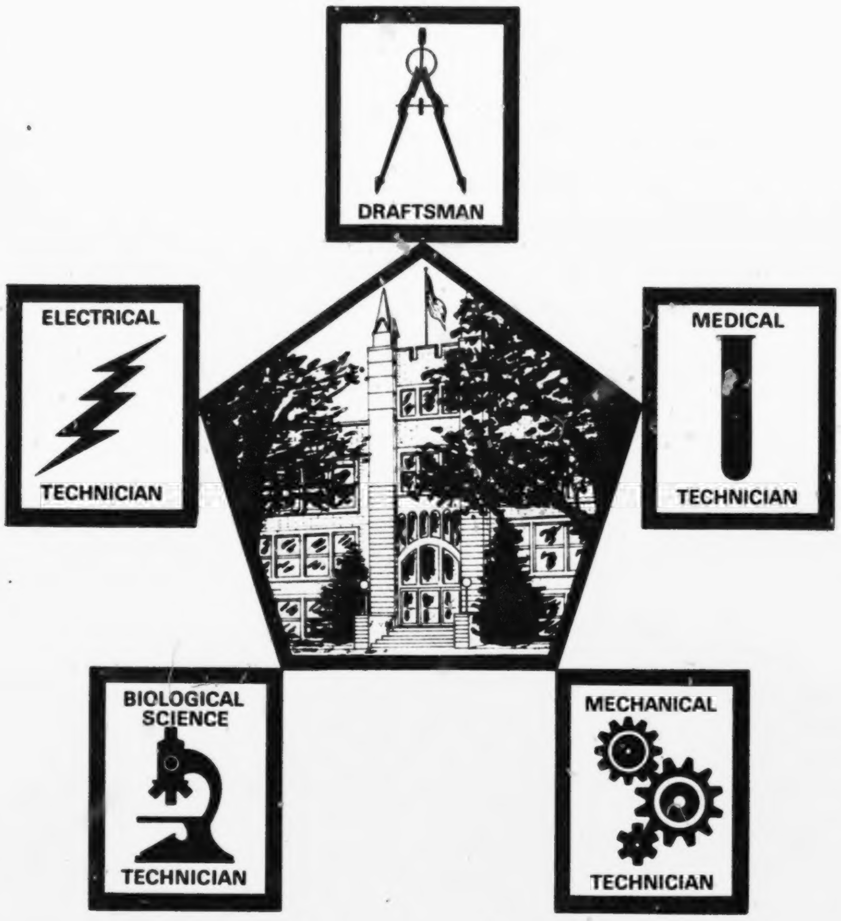
MICHIGAN Technician Need STUDY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DIVISION OF VOCATIONAL EDUCATION • OFFICE OF ECONOMIC EXPANSION

STUDY CONDUCTED BY
FERRIS STATE COLLEGE
BIG RAPIDS, MICHIGAN

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MICHIGAN TECHNICIAN NEED STUDY.

The Present and Projected Demand For Technically Trained People in Michigan.

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James D. Kelly
Project Director

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*4 Michigan State ~~Department~~ of Commerce, Lansing.
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*5 Michigan State ~~Department~~ of Education, Lansing.

Administered Through:
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#3 Ferris State Coll~~ege~~
Big Rapids, Mich~~igan~~ 49307

FOREWORD

The United States economy has moved from an agricultural emphasis, through a manufacturing era and into the present human resources era. Within the shadows of this latest development, a new occupational level is evolving in various types of industry -- technicians. Technicians are specialists. As such, they are significant contributors to research and development teams and they aid engineers in the design and production of various products. There is much conjecture and few facts about these people in the "gray area" between the professional staff and the skilled craftsmen. In an attempt to bring technicians into focus, the Technician Need Study was conducted.

During much of the period that the Technician Need Study was in process another manpower study was being conducted and had paralled interests in technician needs. This was the Michigan Manpower Study conducted by the Battelle Memorial Institute, Columbus, Ohio. However, the findings of the Michigan Manpower Study were based primarily upon study, analysis and evaluation of census and employment data and the estimated needs were projected to 1980 through use of a Socio-Economic Model. In addition, most of the findings were reported for broad groupings of technician classifications by areas such as electronic, draftsman, medical or dental.

The Technician Need Study sought answers to basic questions through the setting of preliminary criteria and thereafter through interviewing in industrial and educational institutions. The questions dealt with many areas. What is a technician? In what industries does he or she work? Where does a technician receive his or her training and is it adequate? How many technicians will be needed in the future?

Dr. John L. Johnson, Director of Administrative Studies, initiated the proposal entitled "The Present and Projected Demand for Technically Trained people in Michigan" and submitted it to the Office of Economic Expansion in the Michigan Department of Commerce and to the Division of Vocational Education in the Michigan Department of Education. It was natural the Ferris State College should ask and seek answers to such questions. It has a long history of interest and involvement in technician education in industrial and health occupations.

One of two methodologies is generally used in manpower studies. The direct approach is to ask the employer for statistical information. The more indirect approach uses statistical information from census data and employment agencies. There are advantages and disadvantages to each method. Both methodologies were used to study Michigan manpower. The Technician Need Study used the direct method of obtaining data and, as previously mentioned, the Michigan Manpower Study, used census and employment data. Findings of the Michigan Manpower Study are cited, where appropriate, in some of the chapters of this report.

The Technician Need Study was started in the fall of 1965 and completed in the early months of 1967. Representatives of various firms and industries were contacted and the information contained in this report was obtained through personal interviews. Without the outstanding cooperation and interest of these firms, the study would not have been possible.

Nothing is static including the demands of the labor market. It reacts to changing conditions and factors. The Technician Need Study itself became a factor in changing the concepts of many employers. In discussions of the needs for, and utilization of, new technicians, interest and awareness of the occupations also were created. As a result, the present and projected needs of firms for technicians increased and expanded during the period the study was in process.

The report of the Technician Need Study has three broad goals: 1) to illuminate the present situation, 2) to describe anticipated increases in the needs for technicians, and 3) to report on educational programs which are available in the state.

It is hoped that couselors, educational planners, and manpower analysts will find this report meaningful and useful.

The technician classifications are so broad and at times ambiguous that no one study can provide totally definitive information on the employment demands for technicians or the job functions they perform. With new technical occupations emerging, research must be continuous. Community and other colleges should take the initiative for local interest studies. It is anticipated there will be increasing employer acceptance of technicians, and a corresponding expansion of training opportunities in the educational institutions and in the employer's educational facilities. Large firms will need to place additional emphasis on career planning.

The Technician Need Study delineates areas where additional research should be undertaken. One such area is the apprentice programs which need to be examined in more detail than space and time allow in this study. The arbitarary elimination of journeymen in the manufacturing and machine trades from a technician classification is sometimes hard to justify when related instruction requirements of certain apprentice training programs and job functions of journeymen are examined.

In some firms it was difficult to identify all technicians. Some employers, by their definitions, classify as technicians only those in salaried positions. They do not include as technicians the hourly-rated employees in employee bargaining units, even though they perform technician functions. These employers resisted efforts to get an evaluation of positions based solely on job functions and educational requirements.

Special acknowledgement is due the Ford Motor Company and its staff at the central office and in the divisions. The Planning and Analysis Unit devoted a great deal of time and effort to providing the information requested. In addition, through their willingness to make the initial arrangements, many visits were made and valuable information obtained at division shops and laboratories. Their interest and cooperation are greatly appreciated.

In general, outstanding cooperation was obtained from most employers. In some firms, more detailed information could have been supplied through visits to plants of the various divisions.

Expressions of gratitude for their interest and involvement are extended to many individuals who assisted in some aspect of the Study. The following deserve special recognition for their help in obtaining industry participation.

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Kenneth B. Porter, Director, Industrial Relations, Employers' Association of Detroit

Fred L. Hendrix, Executive Secretary, Michigan Dental Laboratory Association

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Barton W. LaBelle, Research Associate

James E. Cherry, Research Associate

Miss Vicki S. Waffle, Research Associate

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Secretarial assistance was provided by several individuals, each of whom contributed at various stages during the progress of the study: Mrs. Jean Tata, during the initial project activity; Mrs. Sue E. Muscott, during a period that required attention to detail in interview scheduling and telephone activity in addition to heavy volume of correspondence; Mrs. Rita K. Krol, during the final stages of interview activity and the classification and tabulation of information for the report; Mrs. Sally J. Caudy typed initial drafts of the report; Mrs. Susan A. Stetler computed the estimates on future needs; and Mrs. Bernadette S. Seestadt and Mrs. Mary L. Hilbink typed and performed the secretarial functions in connection with the final drafts.

The preparation of a final report requires reviewers if the content is to be easily read and comprehended by the intended audience. The following staff members at Ferris State College contributed their time and provided a number of ideas and revisions during the final editing of this report.

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James D. Kelly
Project Director

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CHAPTER I

INTRODUCTION

Problems and Objectives

The Technician Need Study is an investigation of the present and future utilization of technicians in Michigan. As stated in the original project proposal, the study is concerned with answering certain specific questions: 1) What is the extent of these crucial manpower shortages in Michigan by technical area or skill, and by area of occupation or industry; and to what extent will these shortages decrease or increase over the next few years in light of current trends? 2) What opportunities for technical training--training beyond the high school level but less than the four year degree level--are available now, and will be needed in the future to assure Michigan industry and business of an adequate supply of trained manpower?

The objectives of the Technician Need Study are, through interviews with several hundred employers in Michigan, to determine the present need for technically-trained personnel in Michigan and to project this need relative to real or anticipated technological change so that such employment opportunities as exist, or may exist, can be filled by trained Michigan residents. Industrial growth and increased employment in Michigan will be determined in part by available resources, and an important resource is qualified technicians in sufficient numbers.

There are numerous publications relating to the need for technically trained people. In this study, the concern is not with broad generalizations as are many of the previously published reports; but rather the concern is with specific occupational needs and the several aspects of technician education and training. Persons in counseling, curriculum development, educational administration, industry, and other areas of manpower development, may find in this study the answers to some important questions which relate specifically to the work, the training opportunities available, and the demand for technicians in Michigan.

Definitions

The central theme of this study is the technician. A technician is defined, for purposes of this study, as an employee whose job requires basic scientific and mathematical knowledge, or other specialized education or training in some aspect of technology, and who, as a rule, works directly with scientists, engineers, or other professional personnel. A technician is a specialist, and may for example, work as a draftsman, a general duty nurse, an air-conditioning mechanic, an electronics mechanic or in many other positions requiring post-secondary education at a subbaccalaureate level.

In general, technicians receive more training in related theory than do craftsmen. However, their training is not as extensive as that of professionals with a baccalaureate or higher degree. Technicians usually become qualified through formal technical training, on-the-job training, or a combination of both.

The term "firms", as it is used in this report, includes hospitals, industrial establishments, and service establishments organized on a profit or non-profit basis. They are classified by Standard Industrial Classification (SIC) code. SIC codes refer to the breakdown of industry into major categories and several stages of subcategories as defined by the Executive Office of the President, Bureau of the Budget, and as used by the Bureau of Census. Although the level of manufacturing industry detail ranges from two-digit codes (major industry group) to seven-digit codes (Products), most of the firms in this study are represented by two or four-digit Standard Industrial Classification (SIC) codes. Information on employers obtained from other sources. The range of detail in manufacturing is illustrated by the following example:

Industry Breakdown	Code	Industry, Product, etc.
Major Industry Group	20	Food & Kindred Products
Industry Group	203	Canned & Frozen Foods
Industry	2033	Fruits & Vegetables
Product Class	20331	Fruits
Product	2033113	Apple Sauce

CHAPTER II

SUMMARY: TECHNICIANS AND THE WORLD OF WORK

Scope of the Study

The Technician Need Study, through interviews and computed estimates, includes a total of 1,218 firms from private industry with a total employment of 1,140,365. This is approximately 49 per cent of Michigan wage and salary workers (excluding government and farm employment) as of January, 1966. In addition, the Study includes estimates for 94 hospitals; but both private and governmental units are included.

It is not possible to draw specific conclusions about the need for technicians in firms employing the remaining 51 per cent of Michigan wage and salary workers. These firms are all of a different size, and primarily of a different type than those included in this Study. On the basis of available information, the actual current and projected figures reported in this Study represent minimum needs. Actual needs, in most classifications, are no doubt considerably higher.

Except for hospitals, statistics were not obtained on technicians employed in governmental units -- federal, state, or local. The principal goal was to determine the needs in private industry. Also, there would be more uniformity in the results obtained by excluding government, the largest service-type employer. However, in hospitals, the nature of the service provided is such that job functions for a particular occupational title would be similar in governmental and nongovernmental units. Therefore, hospitals were included irrespective of control -- federal, state, county, city, voluntary non-profit, or proprietary.

There is general agreement among employers that the need for technicians will increase substantially during the next few years; also, there is a present unmet need for technicians in virtually every classification. The extent of the current shortage, as well as projected need, is presented in detail in subsequent chapters.

The summary, presented in Table 1 by occupational group, is computed from the information furnished by the employers interviewed. This tabulation shows, in percentage figures, present vacancies and projected increases in total employment of technicians. This summary is a rather accurate portrayal of this segment of the labor market. Chapter III provides information on procedures which make clear the Study coverage and limitations.

TABLE 1

PRESENT AND PROJECTED NEED FOR TECHNICIANS EXPRESSED AS A PERCENTAGE OF CURRENT EMPLOYMENT[a]

Technician Classification Areas	Need as a Percentage of Current Employment of Technicians		
	Vacancies 1966	Additional Need 1970	Total Need 1970
Chemical Related	8%	26%	34%
Mechanical Related	8	22	30
Drafting and Design	16	34	50
Electrical and Electronics	18	25	43
Health Related	19	8	27
Civil Related	11	28	39
Information Related	11	41	52
Production Related	10	17	27

a. For employers interviewed--Does not include computed estimates of need listed in Table 2.

The findings in this study are not all new. Other studies also reveal a need for technicians. However, this report provides estimates of needs for specific technician classifications. The primary emphasis is on job functions as a basis for the determination of needs by occupational titles.

Utilization of Technicians

The practice of employing trained technicians is relatively new to many firms of various sizes and types; and although many firms have been developing their own technicians, the programs are often informal and unsystematic. Therefore, the technician's education is frequently directed toward meeting the specific requirements of a particular firm rather than the broader scope of technical education per se.

An examination of recent manpower publications reveals an increasing emphasis in the whole area of technician manpower. Employers are becoming increasingly aware of the advantages of employing these trained specialists. If used wisely, the technician may serve to extend dramatically the productivity of the engineer, the scientist, or other professional. The concept of employing professional and technicians to work as a team provides for maximum utilization of the talents and skills of both groups.

The majority of presently employed technicians are young -- 20 to 30 years in age. Generally, they have had some form of post-secondary training prior to, or after employment. The scarcity of trained technicians is a barrier to more extensive use of these specialists. The overwhelming preference of employers is for specialized training prior to employment. Employers would like to see more post-secondary educational institutions developing good two-year occupational programs. Educational planners often find it difficult to plan a technical program that successfully avoids the extremes of excessive specialization or ambiguous generalization. This difficulty is experienced not only by educational institutions, but also by employers, especially those that have recognized and implemented programs to meet training needs. The technician needs not only "tool" knowledge but also applicable general education.

Many small and medium-sized firms are unaware of the technician training programs available in post-secondary educational institutions. Furthermore, many employers are unaware of the occupational readiness provided through "hands-on" skill development in the shops and laboratories of these schools and colleges. The emphasis on theory in the classroom, together with simulated or actual experiences, provides those who complete these programs with qualifications employers want. This rigorous type of training program is not generally appropriate for the "less able" student.

Inadequacies in the Education of Technicians

Many firms, because of the scarcity of trained technicians, are not in a position to evaluate present training programs. Instead they recommend what these programs should include.

For all technical occupations, employers agree that there are two areas of training which should receive added emphasis. These are English and writing. Although many employers emphasize the desirability of technical report writing in the technician's educational program, there was even greater emphasis on all types of written communication. Situations, events, and problems must be accurately described in writing. Intensive training is required in expository and other types of writing. In many cases, it would be desirable for the technician to have specific training in writing of technical reports. Ability to communicate is of particular importance because the technician is frequently working with others as a member of a team and must be able to give, receive and understand instructions. Other specific inadequacies, which relate to particular areas of specialization, are reported in the appropriate chapters of this report.

Training Opportunities

The findings for this objective study are the basis for most of the recommendations made at the end of this chapter. Satisfying present and future needs requires interested, potential students and the necessary training opportunities. The opportunities involve both the existence of employer sponsored in-service training programs and post-secondary educational facilities. To obtain the information for this Study, two sources were used. The interview questionnaire (Appendix A, Part 3.) includes two and one-half pages of items to which responses were obtained from employers. In addition, officials were interviewed in 39 post-secondary educational institutions.

Employer Responses. Employers are faced with two problems in the search for trained technicians. First, there are not enough graduates of occupational programs to meet the demand. And second, for some specialized occupations, there are no training programs available. In Michigan areas with limited industrial employment opportunities, employers expressed the need for more post-secondary training curriculums to provide industrial technicians. The firm representatives made frequent references to the lack of such programs at their local community colleges.

Cooperative programs are held in high regard by all types of firms, especially when the industry training is an extension of the classroom and laboratory education discipline. There is no substitute for the experience the student gains in work situation. He is better able to appreciate the value of his educational courses when he perceives their application. In essence, a well-planned cooperative program provides both training and experience. Although it might be classed as a secondary benefit, the values of increased communication between school and industry should be appraised.

Cooperative Students from
Community College Drafting Program in
Industrial Services Area
Of Michigan Manufacturer

The relationships between schools and industry are further advanced through tuition-refund programs. Many firms provide the opportunity for their employees to take work-related courses with the firm reimbursing part or all of the tuition expense. These employee-students are enrolled in practically every private and public educational institution in Michigan. The courses they elect range from general education to technical specialities. Some of the courses most frequently taken through tuition-refund programs are: drafting and design, mechanical engineering, supervision, and industrial engineering.

Educational Institutions Responses: Post-secondary educational institutions in the metropolitan areas are being encouraged to set up a number of technician training programs to meet industry needs. In areas with less industrial density, the educational officials expressed various levels of concern for employer needs. In some institutions, there was only superficial recognition. In other areas, the educational officials expressed concern and looked to opportunities for additional offerings of programs for industrial technicians when initial or additional dormitory facilities were completed for in-residence students.

There is a significant trend toward related instruction at the college level for apprentice training programs, especially in the manufacturing and machine trades. The increased numbers of community colleges has made such a trend feasible. Such related instruction also has an impact on the future supply of technicians. Many apprentices are introduced to collegiate level work and develop an interest in continuing their education, at least through the associate degree level.

During the course of this Study, no attempt was made to obtain information on enrollments in institutional training programs under the Manpower Development and Training Act. Such programs can provide enrolees the basic training necessary to be employable, and perhaps develop the initial interest to attain technician status, especially in the drafting, mechanical, electrical and some health occupation fields. However, with the decreasing emphasis on institutional type training, such programs may not make a significant contribution to future supply of technicians. In addition, large numbers that have completed such training are already in the labor markets and are presummed to be included in the information furnished by employers.

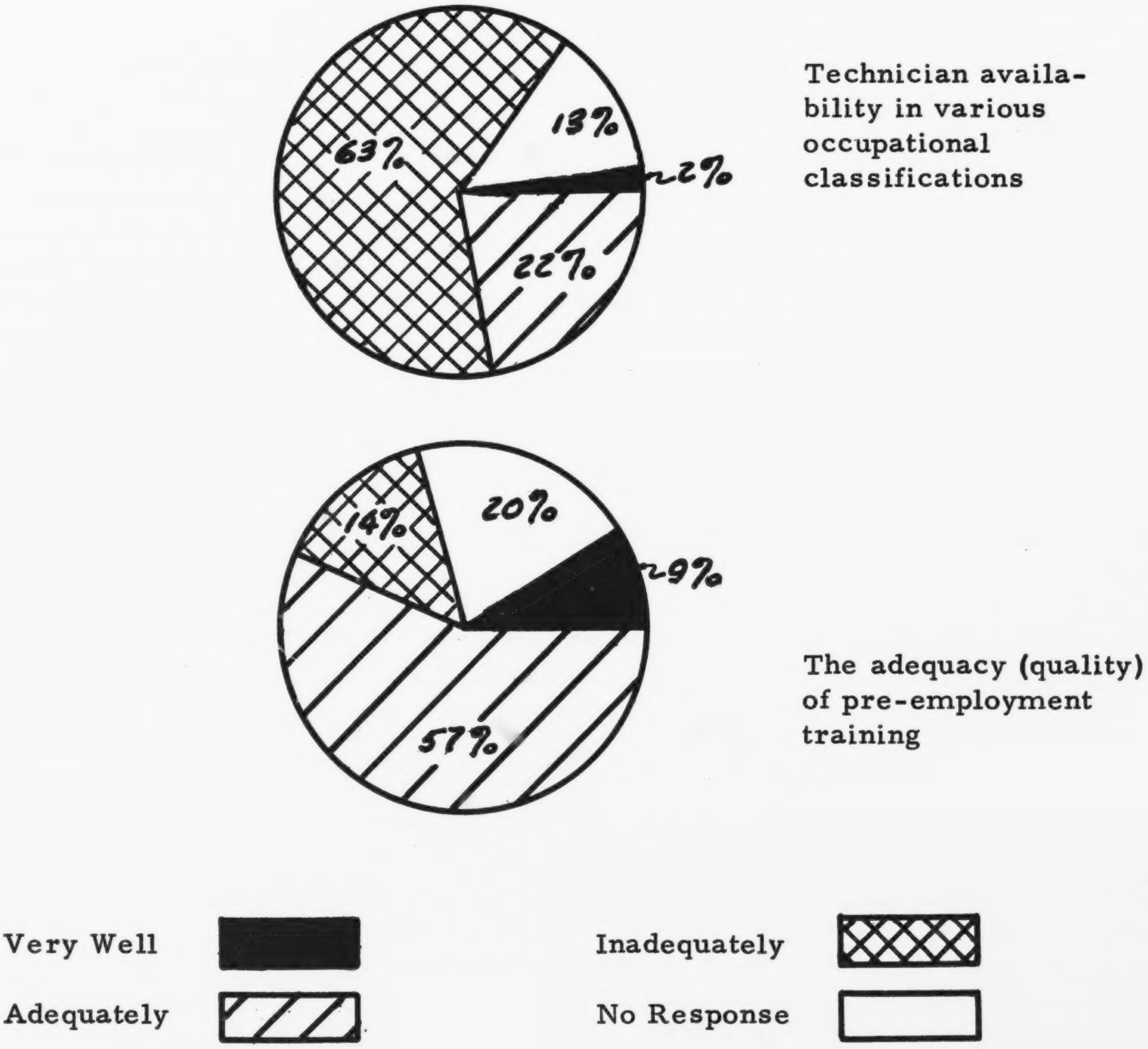
Recruitment

Employers use several sources and methods to recruit technicians. The major source of technicians is up-grading of existing employees, which is recruitment from within. When firms go outside their organization to recruit technicians, they use newspaper ads, employment agencies (private and public), and/or the placement offices of schools, colleges, and universities. Employers have only recently begun to recognize community and other colleges and technical institutes as a source of technicians. Some community colleges deter employers in their recruitment efforts by not providing a placement servide.

Chart 1 presents a percentage breakdown of the employers' responses to the question, "To what extent do existing education facilities (post-high school) in Michigan meet needs for technicians?"

CHART 1

RESPONSES TO QUESTIONS REGARDING TECHNICIAN AVAILABILITY AND QUALITY OF PRE-EMPLOYMENT TRAINING



Technician availability in various occupational classifications

The adequacy (quality) of pre-employment training

Table 2 summarizes information furnished during interviews on enrolments in existing programs and the number of programs planned in post-secondary educational institutions. The enrolments will not meet employer manpower needs set forth in this report. However, the availability does indicate a source for recruitment. Also, the limited enrolments in certain programs may indicate that employer recruiting activities could be broadened to assist educational institutions with their program feasibility problems. Employers with needs for trained technical manpower could help their situation by actively recruiting students for the school or college.

TABLE 2

TECHNICAL OCCUPATION PROGRAMS AND ENROLMENT INFORMATION FURNISHED BY SCHOOLS AND COLLEGES INTERVIEWED.[a]

Program[b]	No. of Programs[c]	No. of Enrollees[c]	Number of Additional Programs Planned
A. Chemical Related			
1. Analytical Research Technician (Resins and Adhesives)	-	-	-
2. Laboratory Assistant (Metallurgical)	3	124	6
3. Chemical Laboratory Technician	5	74	4
4. Laboratory Technician (Petrol. Refining)	-	-	-
5. Unclassified Chemical Technician[b]	-	-	2
Total	8	198	12
B. MECHANICAL RELATED			
1. Optical Technician	-	-	-
2. Mechanical Engineering Technician	17	1,026	3
3. Mechanical Maintenance Man	12	889	7
4. Pneumatic Tester and Mechanic	1	4	-
5. Air-Conditioning (Domestic)	-	-	1
6. Air-Conditioning (Commercial)	1	75	1

TABLE 2 (Cont'd)

Program[b]	No. of Programs[c]	No. of Enrollees[c]	Number of Additional Programs Planned
7. Maintenance Technician	2	19	—
8. Unclassified Mechanical-Related Technician[b]	—	—	8
Total	33	2,013	20
C. DRAFTING AND DESIGN RELATED			
1. Architectural Draftsman	3	209	2
2. Aeronautical Draftsman	—	—	—
3. Electronic Draftsman	—	—	—
4. Electrical Draftsman	1	60	1
5. Structural Draftsman	—	—	—
6. Civil Draftsman	1	16	—
7. Product Draftsman	8	675	—
a. Die Designer	1	265	—
b. Lay-Out Draftsman	—	—	—
c. Industrial Designer	—	—	1
d. Tool Designer	2	236	—
8. Mechanical Draftsman	12	825	6
9. Mine Draftsman	—	—	—
10. Marine Draftsman	—	—	—
11. Oil & Gas Draftsman	—	—	—
12. Air-Conditioning, Plumbing, and Heating Draftsman	—	—	—
13. Map Draftsman	—	—	—
14. Unclassified Draftsman[b]	—	—	—
Total	28	2,286	10
D. ELECTRICAL AND ELECTRONIC RELATED			
1. Electrical Technician	4	165	—
2. Electronic Technician	19	1,236	2
3. Electro-Mechanical Tech.	1	20	1
4. Electronics Mechanic	—	—	—
5. Control-Room Technician	—	—	—
6. Audio Operator	—	—	—
7. Instrumentation Technician	—	—	3
8. Automatic Equipment Tech.	—	—	—

TABLE 2 (Cont'd)

Program[b]	No. of Programs[c]	No. of Enrollees[c]	Number of Additional Programs Planned
9. Unclassified Electrical & Electronic Technician	—	—	2
Total	24	1,421	8
E. HEALTH RELATED			
1. General Duty Nurse	10	984	8
2. Nurse, L. P.	9	589	5
3. Radiologic Technician	4	47	4
4. Electrocardiograph Tech.	—	—	—
5. Electroencephalograph Tech.	—	—	—
6. Medical-Laboratory Asst.	1	17	4
7. Nuclear Medical Technician	—	—	1
8. Medical Assistant	5	174	3
9. Inhalation Therapist	1	20	1
10. Dental Hygienist	1	60	6
11. Dental Assistant	6	251	3
12. Surgical Technician	—	—	—
13. Food Service Supervisor	3	92	3
14. Attendant, Physical Therapy	—	—	2
15. Dental-Laboratory Tech.	1	24	4
16. Optician, Dispensing	1	33	—
17. Medical Technician	—	—	1
18. Medical Secretary	4	182	6
19. Medical Rec's Tech.	—	—	2
20. Medical-Clerical Tech.	—	—	—
21. Unclassified Health Tech.[b]	—	—	3
Total	46	2,473	56
F. CIVIL RELATED			
1. Surveyor	2	113	1
2. Estimator	3	49	—
3. Unclassified Civil Technician[b]	—	—	4
Total	5	162	5
G. INFORMATION RELATED			
1. Clerical Technician	1	8	2
2. Programmer, Detail Junior	4	223	3
3. Reproduction Technician	2	59	4

TABLE 2 (Cont'd)

Program[b]	No. of Programs[c]	No. of Enrollees[c]	Number of Additional Programs Planned
4. Technical Illustrator	3	113	2
5. Unclassified Information Tech.[b]	—	—	—
Total	10	403	11
H. PRODUCTION RELATED			
1. Industrial Engineering Tech.	3	128	4
2. Quality-Control Technician	1	10	1
3. Specification Writer	—	—	—
4. Unclassified Production Tech.[b]	—	—	1
Total	4	138	6
I. SUMMARY: TECHNICIAN NEED, OCCUPATIONAL PROGRAM AND ENROLMENT DATA			
1. Total Programs in all areas 1966-67 school year	158		
2. Total Enrolments all programs		9,094	
3. Total Additional Programs Planned			128
4. Technician Need from Table 3			
a. Total Requirements 1970[d]		106,960	
b. Additional 1970 needs only		20,939	

a. Data furnished by 29 public and one private post-secondary educational institution in Michigan

b. Unclassified technician category in each of the areas includes programs with curriculum content not easily identified with functional definitions for occupational titles used in study.

c. Programs and enrolment figures furnished at beginning of 1966-67 school year.

d. Requirements include current employment and vacancies plus projected additional need in 1970 excluding replacements for retirements, deaths, and other employment terminations.

Residual Effects of Study

While the Technician Need Study was in process, it became apparent that the Study itself was stimulating interest in, and an awareness of, technicians on the part of employers. In effect, the Study became a communication vehicle between employers of technicians and educational institutions. The employer's awareness that there were occupational training programs for technicians affected his responses to several aspects of the study. The continuation of this interest is hard to predict. The results of stimulation were themselves diverse.

Many employers that currently utilize only a few technicians anticapated increasing needs by 1970. If these demands materialize, the gap between supply and needs will widen considerably. Educational institutions must make preparations now if severe shortages are to be avoided. An increased supply of trained technicians may cause an increased demand, at least over the short run, rather than a reduction of need. If this were to occur, the projected needs presented in this report will fall far short of actual needs.

In firms interviewed, the study caused employers to re-evaluate their minimum educational requirements for some technical positions. An examination of the job functions revealed to the employer that the educational requirements were not always realistic. In some cases, a baccalaureate degree was required for positions in which the job functions could be performed by a technician. Although in some instances there was a consideration for promotional opportunities. Other times, the firm was expending money and time to train existing employees when recruitment of trained technicians would have been more profitable. The long range effects of these tentative moves by the employers may result in an examination of the technician's place in their organizations, and in more realistic educational requirements in terms of job functions to be performed.

In reviewing the information obtained during all interviews, there were areas where no reliable "average" relationship could be determined between total employment and total technicians. This was especially true for manufacturers with a total employment between 250 and 800. Therefore, the conclusions were drawn from an analysis of the firm's type of product or service and by the specific technician occupational title. The needs of hospitals could not be estimated by drawing any comparisons between total hospital employment and presently employed technicians. In part, this was attributable to the practice of hospitals contracting for certain services. In other cases, the hospitals did not provide certain services nor did they indicate any plans for doing so in the future.

Recommendations on the Basis of this Study

Industry's requirements for technicians, listed by occupational classification in table 3, can be met only through the availability of a supply of informed and interested young men and women who will take advantage of training opportunities. Some employers expressed difficulties in the recruitment and selection of qualified persons for their apprenticeship programs. Many employers expressed a need for additional occupational programs in post-secondary educational institutions serving the area in which the firm provides employment opportunities. The officials, in the schools, colleges and universities interviewed, expressed a critical need for additional students in some occupational programs desired by employers. Educational officials, in areas with limited industrial employment opportunities, were optimistic regarding the possibility of increased enrolments in technician programs when initial or additional residence facilities were completed on their college campuses.

Therefore, the summary of findings, from interviews with employers and visits at educational institutions, points toward report recommendations that emphasize the need for informed and interested young men and women able to meet the future demands for technicians. Opportunities for training must be provided by employers or post-secondary schools and colleges.

Possible Courses of Action. Nine distinct but related recommendations are set forth for consideration by employers and the schools, colleges, and universities interviewed. The primary theme of meaningful and realistic communication practices transcend all the following recommended courses of action. These recommendations, it should be noted again, are based on interview findings made through pre-interview planning by the employer and a structured interview session conducted on the employer's premises by a member of the Study staff. (See Appendix A, Part 3 for format and examples of questions.)

1. More intensive and extensive channels of communications should be developed between the educational institutions and employers of their graduates. The inadequacy of present communications was evident from the employer's lack of awareness of available sources of needed personnel and from the lack of programs in educational institutions to fulfill essential personnel needs of employers. The communication practices can be of many different types, among which could be:

   a. Designated faculty representative to make continuing contacts on a scheduled basis.

b. The use of faculty members for vacation replacements.

c. An exchange program wherein both the college and employer needs are emphasized in selection criteria and job requirements that provide for employer representatives to serve as instructors and the college faculty member to serve as the replacement during a specified period corresponding to the school terms.

d. Area workshops for management employees and school faculty members that utilize employer and college representatives as discussion leaders.

2. Industry officials and school administrators should, together, provide opportunities for high school and post-secondary counselors to develop a more realistic concept of a "technician." Counselors should be more aware of what technician occupations exist and of the job functions associated with each occupation. The lack of interest some counselors may display for any post-high school education program which is less than a baccalaureate degree level should be avoided.

3. Counselors should understand that technician training programs are not generally appropriate for the "less able" student. This, plus the fact that most technician training programs require at least average ability along with particular aptitudes and interests, was emphasized by many of the employers interviewed. Not everyone is qualified by temperment and ability to be a technician. All characteristics of the student should be considered.

4. Employers, almost unanimously, recommended that administrators and faculty at post-secondary institutions should take the initiative for the development of additional cooperative educational programs for technicians. Employers generally agree that these types of training programs are invaluable. Certain aspects of the work situation are often beyond simulation in the classroom. Financial aid to the students and increasing contact between employers and educators are secondary benefits. In addition, employers emphasized the need for a coordinator of cooperative education on the college staff.

5. In those community colleges where such programs are not presently offered, the administration and faculty, with representatives of industry, should thoroughly study the opportunities and the feasibility of providing related instruction for apprenticeship programs in the manufacturing and machine trades. In addition to the college serving industry directly, the opportunities for post-secondary technical education becomes known to the apprentice. Employers emphasized the need for open-ended

related instruction in apprenticeship programs as a method of meeting their future need for technicians.

6. Community colleges with resident (dormitory) facilities should examine the feasibility of additional programs for technical training. The regional nature of their student body would provide opportunity for a sufficient number of graduates that could meet not only local industry needs but also assist in meeting the technician needs elsewhere in Michigan.

7. Employers lack of information relating to ongoing technician training programs suggests community colleges with occupational programs study the operations of their placement service. In those colleges where such a service has not been provided, the total range of benefits and costs should be examined to determine the feasibility of placement office functions.

8. Educators and employers alike urge that more technician training programs be developed around the core-curriculum concept. Many different meanings are attached to the "core" ideas which are currently used by employers and educational institutions. To the employer, it means a minimum of detailed specialization in any one particular classification in an occupational group, such as drafting and design related or electrical and electronic related. For the schools and colleges, the core idea involves curriculum planning wherein the first year of post-secondary has subject requirements common to many specialized occupational titles, such as those found in the health related area. The training for many technical classifications is applicable to this approach. Core-curriculums reduce duplication during the first year and at the same time increases the occupations for which training is available.

9. Curriculum development personnel may examine the tables in this report to determine types of firms in which further study should be made on a local basis. More significant information could be obtained by determining the types of firms in which the greatest need exists for certain types of technicians. Thereafter, arrangements could be made for a detailed study of job functions in such firms as may be located in the area served by the educational institution.

TABLE 3

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS IN FIRMS MEETING CRITERIA FOR INCLUSION IN STUDY.

Classification	Employers Interviewed[a]		Employers not Interviewed[b]		
	1966 Employment and Vacancies	Additional Need 1970	1966 Requirements	Additional Need 1970	Total Requirements 1970
A. CHEMICAL RELATED					
1. Analytical Research Tech. (Resins and Adhesives)	182	37	14	3	236
2. Laboratory Assistant (Metallurgical)	548	147	43	25	763
3. Chemical Lab. Technician	2,646	712	267	83	3,708
4. Laboratory Technician (Petrol. Refining)	79	7	3	1	90
5. Unclassified Chemical Technicians	80	24	c	c	104
Total	3,535	927	327	112	4,901
Employed, 1966	3,271				
Vacancies, 1966	264				
B. MECHANICAL RELATED					
1. Optical Technician	13	7	8	4	32
2. Mechanical Engineering Technician	3,367	586	199	69	4,221
3. Mechanical Maintenance Man	1,742	425	1,135	321	3,623
4. Pneumatic Tester and Mechanic	86	36	4	5	131
5. Air-Conditioning (Domestic)	36	112	45	52	245
6. Air-Conditioning (Commercial)	117	70	248	95	530
7. Maintenance Technician	1,559	286	219	46	2,110
8. Unclassified Technical-Related Technicians	536	155	c	c	691
Total	7,456	1,677	1,858	592	11,583
Employed, 1966	6,890				
Vacancies, 1966	566				

TABLE 3 (Cont'd)

Classification	Employers Interviewed[a]		Employers not Interviewed[b]		Total Requirements 1970
	1966 Employment and Vacancies	Additional Need 1970	1966 Requirements	Additional Need 1970	
C. DRAFTING AND DESIGN RELATED					
1. Architectural Draftsman	583	152	1,832	402	2,969
2. Aeronautical Draftsman	43	118	139	357	657
3. Electronic Draftsman	142	125	145	195	607
4. Electrical Draftsman	539	217	140	20	916
5. Structural Draftsman	243	83	121	16	463
6. Civil Draftsman	97	34	52	47	230
7. Product Draftsman (n.e.c.)	4,720	1,168	99	50	6,037
a. Die Designer	477	250	17	299	1,043
b. Lay-Out Draftsman	879	333	96	245	1,553
c. Industrial Designer	1,080	239	91	150	1,560
d. Tool Designer	1,271	1,001	84	266	2,622
8. Mechanical Draftsman	3,918	1,141	437	177	5,673
9. Mine Draftsman	56	52	2	2	112
10. Marine Draftsman	21	2	0	10	33
11. Oil & Gas Draftsman	75	31	4	49	159
12. Air-Conditioning, Plumbing & Heating Draftsman	172	75	53	47	347
13. Map Draftsman	43	9	30	2	84
14. Unclassified Draftsman	1,283	342	c	c	1,625
Total	15,642	5,372	3,342	2,334	26,690
Employed, 1966	13,464				
Vacancies, 1966	2,178				
D. ELECTRICAL AND ELECTRONIC RELATED					
1. Electrical Technician	676	225	269	25	1,195
2. Electronic Technician	749	455	332	163	1,699
3. Electro-Mechanical	858	87	87	68	1,100
4. Electronics Mechanic	225	142	50	36	453
5. Control-Room Tech.	9	0	15	0	24
6. Audio Operator	26	5	19	9	59
7. Instrumentation Tech.	418	101	47	33	599
8. Automatic Equipment Technician	958	50	112	8	1,128

TABLE 3 (Cont'd)

Classification	Employers Interviewed[a]		Employers not Interviewed[b]		Total Requirements 1970
	1966 Employment and Vacancies	Additional Need 1970	1966 Requirements	Additional Need 1970	
9. Unclassified Electrical & Electronic Technicians	547	80	c	c	627
Total	4,466	1,145	931	342	6,884
Employed, 1966	3,768				
Vacancies, 1966	698				
E. HEALTH RELATED					
1. General Duty Nurse	14,467	626	3,968	1,465	20,526
2. Nurse, L. P.	9,036	650	2,599	1,136	13,421
3. Radiologic Technician	1,088	129	286	148	1,651
4. Electrocardiograph Tech.	263	32	78	39	412
5. Electroencaphalograph Tech.	146	18	26	36	226
6. Medical-Laboratory Asst.	1,218	184	414	61	1,877
7. Nuclear Medical Technician	38	12	13	17	83
8. Medical Assistant	12	4	3	0	19
9. Inhalation Therapist	248	49	85	53	435
10. Dental Hygienist	18	8	5	7	38
11. Dental Assistant	62	8	20	10	100
12. Surgical Technician	1,028	173	288	215	1,704
13. Food Service Supervisor	165	78	39	18	300
14. Attendant, Physical Therapy	185	69	56	54	364
15. Dental-Laboratory Tech.	408	24	8	1	441
16. Optician, Dispensing	12	0	6	0	18
17. Medical Tech :MT-(ASCP)	671	173	353	90	1,287
18. Medical Secretary	339	93	162	44	638
19. Medical Rec's. Technician	181	62	82	49	374
20. Medical-Clerical Technician	489	21	159	7	676
21. Unclassified Health Tech.	81	20	c	c	101
Total	30,155	2,311	8,650	3,450	44,691
Employed, 1966	24,262				
Vacancies, 1966	5,893				
F. CIVIL RELATED					
1. Surveyor	141	41	98	43	323
2. Estimator	1,019	240	750	123	2,132
3. Unclassified Civil Tech.	236	107	c	c	343
Total	1,396	388	848	166	2,798

TABLE 3 (Cont'd)

Classification	q Employers Interviewed[a]		Employers not Interviewed[b]		Total
	1966 Employment and Vacancies	Additional Need 1970	1966 Requirements	Additional Need 1970	Requirements 1970
Employed, 1966	1,258				
Vacancies, 1966	138				
G. INFORMATION RELATED					
1. Clerical Technician	299	76	154	66	595
2. Programmer, Detail Junior	943	472	513	292	2,220
3. Reproduction Technician	316	61	105	29	511
4. Technical Illustrator	777	345	44	38	1,204
5. Unclassified Information Technicians	39	21	c	c	60
Total	2,374	975	816	425	4,590
Employed, 1966	2,132				
Vacancies, 1966	242				
H. PRODUCTION RELATED					
1. Industrial Engineering Tech.	951	304	161	31	1,447
2. Quality-Control Technician	1,486	135	778	140	2,539
3. Specification Writer	574	87	30	5	696
4. Unclassified Production Technicians	120	21	c	c	141
Total	3,131	547	969	176	4,823
Employed, 1966	2,845				
Vacancies, 1966	286				

a. Data furnished by employers.

b. Computed. (See Appendix A, Part 7 for details on method of computation).

c. Estimates have not been made for the unclassified category of technicians.

CHAPTER III

PROCEDURE

Scope of Information Sources

The procedures used in this study, discussed in detail below, are briefly as follows: During a period of about 15 months, personnel in industrial and business firms throughout Michigan were interviewed regarding all aspects of technician needs. The firms included in this sample were selected on a nonrandom basis so as to obtain maximum coverage--geographically, by type of industry, and as a percentage of the total labor force of the state. For most industrial classifications the minimum size firm in the sample had 250 employees; but in some types of industry, firms with a few as 100, 50, 8, or even 3 employees were included. The specifics are included, along with other survey instruments, in the several appendices. Hospitals, for several reasons which are discussed below, are treated somewhat as a special case.

Private Industry. Excluding hospitals, (SIC 806), officials of 61 Michigan firms were interviewed in the Technician Need Study. Total employment of these firms when the study was started was 900,104. Also, there were 33 responses by correspondence and 53 telephone responses from employers who employ few or no technicians. Firms included in these two categories had an employment of 30,992. Therefore, the tota employment of participating firms, excluding hospitals, was 931,096. (See Appendix A, Part 6.)

There were 517 firms which met the criteria--established on the basis of number of employees--but which did not participate in the study. They had a combined employment of 209,269. This also is exclusive of hospitals. Estimates of present and future need for technicians in these firms are computed. (See Appendix A, Part 7, for method of computation.)

Therefore, the employment figures for firms meeting the criteria, interviewed and not interviewed, represented 49 percent of the employment in Michigan as of January 1, 1966, excluding government and farm The hospital information which include government units, is discussed in the next subsection.

Findings for five occupational classifications are inconclusive. These classifications are agricultrual-Engineering Technician, Test-Reactor Operator, Wood Technician, Dairy Technician, and Glass Technician. Few firms interviewed employed these types of technicians. It is possible that the nonrandom nature of the sample may have eliminated employers of these technicians.

Hospitals. Officials of 73 hospitals were interviewed. This includes 64 hospitals listed in the 1965 Guide Issue of Hospitals, Journal of the American Hospital Association and nine osteopathic hospitals. The 64 AHA registered hospitals that participated represent approximately 63 percent of total employment in the 262 registered hospitals listed. The nine osteopathic hospitals which participated represent approximately 61 percent of the total Michigan employment in osteopathic hospitals as indicated by data received from the Michigan Association of Osteopathic Physicians and Surgeons.

Twenty-six of the hospitals in the survey are under some kind of governmental control. This was the only departure from the usual procedure of not including government employment in the Technician Need Study.

In the health occupation area, the needs emphasis is on actual current vacancies for which the employer was actively recruiting. Also, the employer was requested to estimate future needs on the basis of an existing level of medical care and hospital facilities. This means that needs are stated on an actual, rather than desirable, standard of patient care to avoid obtaining information on shortages for a level of medical care and hospital facilities that were not even in the planning stage at the time of the interview. For example, the estimates of employer needs could place undue emphasis on requirements for registered nurses who would perform many functions that could be done by a licensed practical nurse. In the clinical laboratory, the need might be medical laboratory assistants but the employer would prefer to have medical technologists.

Assumptions

The procedure followed in the Technician Need Study is based on certain assumptions. These assumptions give form to the Study and determine to some extent the scope and depth of the findings. It was assumed first that more valid information could be obtained from personal interviews than from other methods.

Second, it was assumed that employers could answer best the questions relating to current employment, current vacancies, estimated needs for 1970, and other characteristics of technicians. (See Appendix A, Part 3-a)

The third assumption was that a realistic picture of the present and future utilization of technicians in private industry and hospitals in Michigan could be constructed from interviews in a selective sample of from 700 to 1,000 firms.

Establishment of Criteria

The selective, non-random sample of firms is based on number of employees, and type of product (as designated by Standard Industrial Classification code). (See Appendix A, Part 1.) With the exception of government institutions and farms, all firms employing 250 or more are included. However, it is assumed that firms concerned with certain types of products or services would have greater need for technicians. For these classifications the employment criteria for inclusion is below 250.

Several sources of data were used to determine the names of firms meeting the criteria. The major source of information on firms, other than hospitals and schools, was the Michigan Employment Security Commission (MESC) which obtains the information through reports from employers covered under the Michigan Employment Security Act. The information was made available under the provisions of Act No. 398 of the Public Acts of 1965. The data are arranged by the Standard Industrial Classification and gives the employment of each employer unit.

Prior to receipt of the MESC data, information on firms was obtained from the Michigan Directory of Manufacturers which lists firm name, number employed, officials, and products. Sources of information on hospitals were the Journal of the AmericanHospital Association, Hospitals, the Guide Issue of 1965, and data supplied by the Michigan Association of Osteopathic Physicians and Surgeons. Lists of private and public educational institutions were provided by the Michigan Department of Education. In addition, school bulletins were used to select institutions providing two-year occupational programs for technicians.

Methodology

All firms meeting the criteria were sent a letter explaining the study and asking for their participation. (See Appendix A, Part 2.) These participation letters were directed to either the firm President or Personal Director. Certain classifications of firms were sent a more individualized participation letter. (See Appendix B, Part 4.)

In addition to the individualized participation letter, medical and dental laboratories were sent a preliminary questionnaire which included definitions for the technical occupations associated with such laboratories. They were asked to complete and return the questionnaire to the study office. When this was received, a personal interview was scheduled at the laboratory. (See Appendix B, Parts 2 and 3)

Information sheets were enclosed with all participation letters. The information sheets present essential data in an easy to read outline form. (See Appendix A, Part 2.) The questionnaire and the definitions of job functions condensed from the Dictionary of Occupational Titles, were included with participation letters. (See Appendix A, Part 3-b) The technical occupation definitions are an enumeration of job functions associated with a particular occupational title. If a firm did not respond, a follow-up letter was sent. (See Appendix A, Part 5.)

In most cases, but not all because of the time limitation, a staff member followed up with a phone call if there was no response to the particiaption letter. Only a small number of firms refused to participate. A tentative appointment was made after receiving a response to the participation letter, or through the telephone follow-up, and a confirmation letter sent. (See Appendix A, Part 4.)

The interview took place at the firm's offices. The length of interviews varied from one to five hours. On many occasions, the Study staff member talked with several persons. The firm representatives might include the personnel director, training director, research director, supervisory personnel, and/or technicians. During the interview, supplementary questions on the inadequacies of technical education were asked. (See Appendix A, Part 3-c) These questions were used to aid the interviewee in furnishing more specific information. Answers to these questions are an important part of this report.

In the early months of the Study, many hospitals were interviewed. Evaluation of the data collected revealed that additional technical classifications should have been included. Subsequently, a supplementary questionnaire and definitions were sent to these hospitals for completion. (See Appendix B, Part 1.)

In large corporations, composed of several divisions or units, the information was usually supplied at the corporate office. In addition, supplementary interviews were conducted at the divisional level to obtain information on educational requirements for technicians. It was believed that those closest to the work of the technicians could best answer these questions. Interviews involved officials in a total of 688 firms. In addition, 31 supplementary information interviews were scheduled at the division level. The breakdown of interviews by SIC and employment is in Appendix A, Part 6.

Estimates of Technician Need

The estimated need for technicians in 1970 was obtained by summation of data from two sources. Employer representatives projected their estimated need for technicians at the time of the interview. The reliability of the estimates of technician need vary with a firm's ability and interest in manpower planning. Some firms were unable to provide statistics on their future need for technicians. Neither the employer estimates nor the computed estimates include technicians needed for replacements caused by death, retirements, or other attrition. As a result, the future need for technicians, as presented in this report, is undoubtedly conservative.

Secondly, the future need of technicians for firms not interviewed, but which met the study criteria, is computed. Each technical classification was computed separately. Firms were grouped by Standard Industrial Classification code. The total employment of firms not interviewed in each SIC code was divided by the total employment of firms interviewed and meeting the criteria in each SIC code. The resulting rate was applied to present employment of technicians, present technician vacancies, and projected total technician employment for 1970 in firms interviewed, to arrive at an estimate of technician needs in the firms not interviewed. (See Appendix A, Part 7.)

Employer estimates on classifications not listed in the questionnaire have been included under the heading "unclassified." Computed estimates were not made of present and future need for technicians in the "unclassified" category; that is, estimates were made only for the classifications listed under occupational title definitions included in Appendix A, Part 3-b.

Limitations of Study

There are several factors limiting the Study findings. First, the Study does not attempt to estimate present and future needs for technicians in all Michigan firms. The study is based on a non-random sample of firms; and technicians needs, as reported, are only for these and other firms which meet the level-of-employment criteria.

The Study elicited both objective information and subjective opinions from the interviewees. Information pertaining to the educational requirements and inadequacies in the education of technicians is based on the subjective evaluation of the employer. Characteristics of subjectivity should not conceal the value of such information. The employer places personnel in positions on the basis of abilities he believes are necessary for effective performance. Subjective though these opinions may be, they are real factors in the area of job placement.

The statistics related to future needs for technicians are limited to the extent an employer was giving attention to the planning for manpower requirements. Individual firms vary in their emphasis on such planning. The employer and computed estimates of technicians need do not take into account the changes brought about through changing technology. However, it has been assumed that the rate of adoption and implementation of automated processes will be such as to have only minimal influence by 1970.

CHAPTER IV

TECHNICIAN OCCUPATIONS WITHIN THE CHEMICAL RELATED FIELD

Present Employment, Present Vacancies, and Projected Needs for 1970

In general, technicians in the chemical technology field are found either in chemical plants, including research and development laboratories, or in the laboratories of other industrial firms. Experiences with technicians in one of the chemical plants visited are reported in an article in Research Management.[1] The definition for chemical laboratory technicians represents the broadest grouping of functions in the chemical related field for a chemical technician. (See Appendix A, Part 3b.) He conducts chemical and physical laboratory tests and makes qualitative and quantitative analysis of materials for purposes such as development of new products, materials, and processing methods, and for maintenance of health and safety standards. They may also be classified according to an area of specialization such as (a) Analytical Research Technician (Resins and Adhesives), (b) Laboratory Assistant (metallurgical), or (c) Laboratory Technician (Petroleum Refining).

As supportive personnel, chemical technicians are an integral part of a group that consists of professional chemists, chemical engineers, craftsmen, or maintenance personnel. In the firms interviewed, the technician's functions are performed in research, design development, production of chemical products, or the testing of raw materials, processes and finished products. The variety of duties depends upon the type of firm, its line of product or products, and whether the chemical laboratory technician is employed in the laboratories of industrial firms manufacturing a variety of products or in the chemical plant. In the firms interviewed, most of the chemical technicians are employed in chemical plants, drug manufacturers, and in research departments of large manufacturers. The chemical and allied products firms produce both industrial and consumer goods.

The chemical technician carries out the day to day work in research and development. In most cases, the work is performed as a part of total team effort. Technicians work without close or detailed supervision and perform work with many different types of equipment. The routine tests performed in quality control are usually a part of the higher level responsibilities performed. Quality control work, on a full-time basis, is usually performed by employees with less training.

In the research and development functions, many large manufacturers outside the chemical industry utilize a number of technicians. The chemical technicians aid the scientists and engineers in the search for new materials and new processes. The laboratory team refines and applies basic research on the fringes of science for use in the pragmatic world of industry. Within the firms interviewed, there are presently employed 3,271 chemical technicians. Employers have difficulty finding qualified persons and at present have 264 vacancies. Without considering retirements and transfers from the firms interviewed, it is anticipated their needs in 1970 will call for an increase of 1,127 chemical technicians which would bring the total employment of such technicians in these firms to 4,462. Table 4 presents a detailed breakdown of interview findings.

TABLE 4

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS INTERVIEWED FOR TECHNICIANS IN THE CHEMICAL RELATED FIELD

Classification	Present Employment	Present Vacancies	Total Projected Employment 1970
1. Analytical Research Tech. (Resins and Adhesives)	166	16	219
2. Laboratory Assistant (Metallurgical)	520	28	695
3. Chemical Laboratory Technician	2,434	212	3,358
4. Laboratory Technician (Petroleum Refining)	78	1	86
5. Unclassified Chemical Technician	73	7	104
TOTAL	3,271	264	4,462

Table 4 presents the employment data as found in the firms interviewed. The technicians are employed in the types of firms as indicated in Table 5. Where the percentage of total employment for any occupational title by Standard Industrial Classification (SIC) code is less than 5 per cent, the types of firms are grouped and the combined percentage figure reported.

TABLE 5

DISTRIBUTION OF TECHNICIAN EMPLOYMENT BY CLASSIFICATION OF FIRMS

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
1. Analytical Research (Plastics)	Various, (See Appendix A, Part 1)	22, 25, 26, 30, 32, 35, 39, 89	11.93
	Chemical and Allied	28	60.79
	Primary Metal	33	9.66
	Electrical Machinery	36	6.25
	Transportation Equip.	37	11.37
2. Laboratory Assistant (Metallurgical)	Various, (See Appendix A, Part 1)	25, 28, 30, 34, 36, 38, 49, 73, 89	9.02
	Metal Mining	10	6.86
	Primary Metal	33	35.88
	Machinery (Except Elec.)	35	13.73
	Transportation Equip.	37	34.51
3. Chemical Laboratory Technician	Various, (See Appendix A, Part 1)	10, 14, 19, 20, 25, 26, 29, 30, 31, 32, 34, 35, 36, 38, 39, 49, 89	18.14
	Chemical and Allied	28	57.78
	Primary Metal	33	6.36
	Transportation Equip.	37	15.96
4. Laboratory Tech. (Petrol. Refining)	Various, (See Appendix A, Part 1)	35, 49	10.13
	Petroleum & Coal Products	29	59.49
	Primary Metal	33	16.45
	Transportation Equip.	37	12.66

Projections for all firms meeting the criteria were carefully analyzed. It is not considered feasible to make projections for firms that did not meet the criteria; that is, the firms with less than a predetermined number of employees for their particular type (SIC Code.) On the basis of information obtained from firms interviewed, estimates of need are shown in Table 6 for like firms meeting the criteria as to the number of employees. (See Appendix A, Part 1).

TABLE 6

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE CHEMICAL-RELATED FIELD, 1970[a]

	Estimates of Occupational Need		
Classification	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. Analytical Research Technician (Resins and Adhesives)	219	17	236
2. Laboratory Asst. (Metallurgical)	695	68	763
3. Chemical Laboratory Technician	3,358	350	3,708
4. Laboratory Technician (Petrol. Refining)	86	4	90
5. Unclassified Chemical Technician	104	d	104
TOTAL	4,462	439	4,901

a. Data includes only those needs of employers who met criteria for inclusion in the study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers as shown in Table 4.

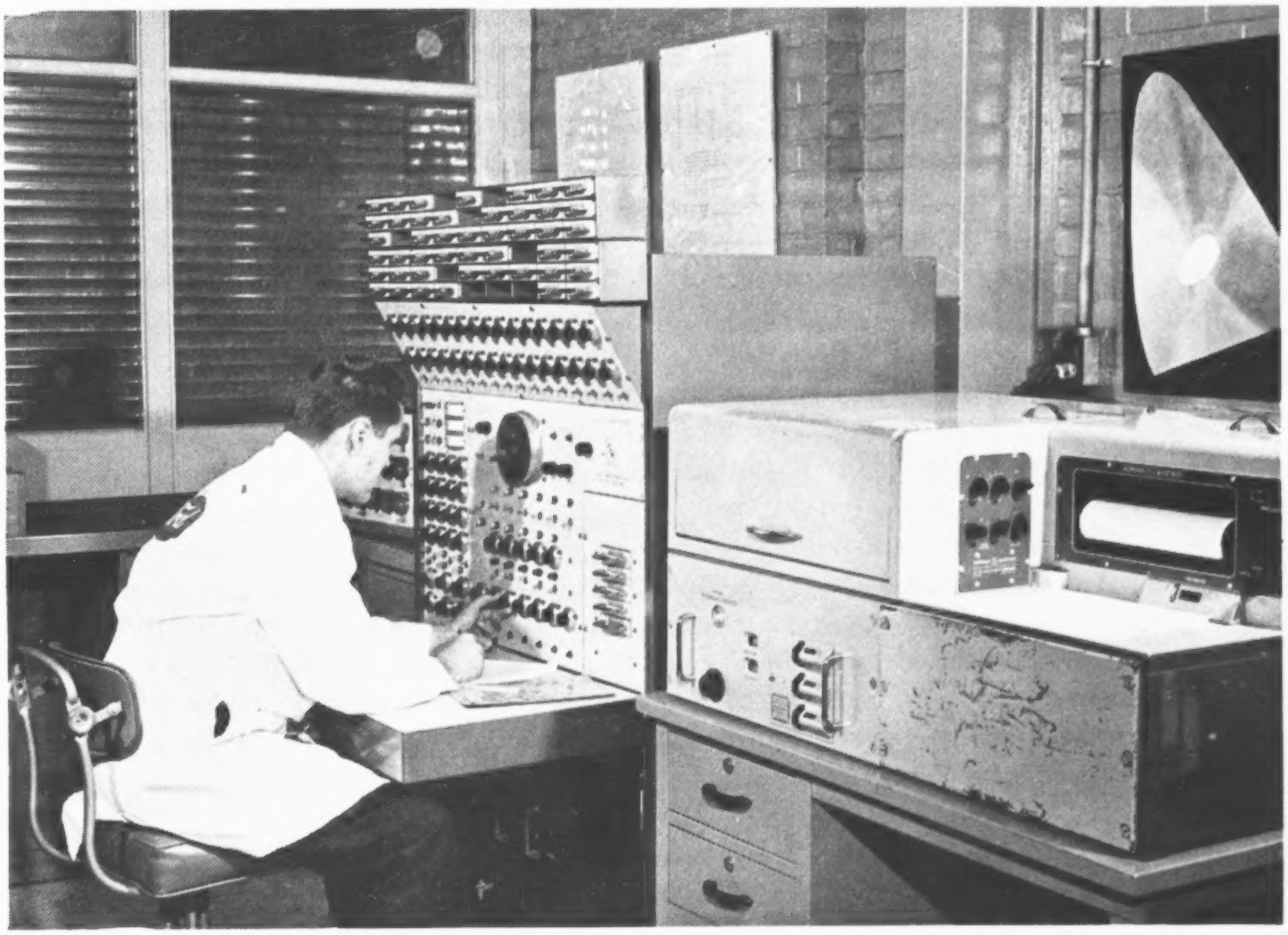
c. Computed. (See Appendix A, Part 7, for method of computation.)

d. Estimates have not been made for the unclassified category of chemical technicians.

Minimum Educational Requirements

Until a few years ago, employers of large numbers of chemical technicians were interested only in four-year graduates. When less than a four-year graduate was employed, it was usually a student who had completed only one to three years of a four-year program. However, it was found that the "dropout" had insufficient "hands-on" skill development. The four-year graduate, when employed, usually received his "hands-on" training at the level of work customarily performed by technicians. Qualifications created a problem, in that the individuals became dissatisfied with the lack of challenge in the work assigned. Therefore, both the chemical plants and the laboratories in other industrial firms have become interested in technicians with two-year post-secondary training who have the depth in chemical theory but without the general education usually obtained in a baccalaureate program. A dropout hired after two years of college does not usually possess the same level of skill development as a two-year graduate of a well-structured technical program. This lack of qualification results from the less intensive concentration in occupational training during the first two years of a four-year program.

Functions which may represent only routine tasks for a college graduate are challenging to a technician. To fully utilize the professional talents of scientists and engineers, technicians are added to the laboratory team. The work of chemical technicians on such laboratory teams is of a fairly sophisticated nature. It requires a strong background in the sciences and an understanding of college level mathematics. In most cases, the minimum educational requirement is a two-year post-high school program plus on-the-job training. The need, the type of work, and the educational preparation for chemical technicians is stated in a pamphlet of the Manufacturing Chemists Association.[2]



Technician at controls of computerized
color-matching
equipment in color research activity of
Michigan manufacturer

Chemical technicians with less than two years of post-high school education are usually employed to perform the more routine tasks. At this lower level are high school graduates who have demonstrated aptitude in the sciences and mathematics. They are given on-the-job training and may be required to supplement their education through in-plant training programs and/or tuition refund programs. Even when employed with high school education as a minimum, employers may require additional education before such employees can qualify for advancement.[3]

In smaller firms--those employing from one to ten chemical technicians--technicians are seldom graduates of post-high school institutions. The minimum educational requirement is graduation from high school. Generally, high school graduates are employed and are given formal and informal on-the-job training. If the employee has aptitude in the science area, he may acquire enough knowledge and experience to attain technician level. At such a level he performs the functions of a chemical technician as described in the Dictionary of Occupational Titles. Some paper manufacturers provide an illustration of this situation. Their technicians are usually concerned with product testing and quality control. Working in the laboratories are chemical technicians who have acquired their knowledge and skill on the job.

Preferred Educational Requirements

Both large and small firms agree that it is desirable for chemical technicians to have from one to two years of post-high school education. The additional chemistry and mathematics is essential if technicians are to work as productive members of the laboratory team. The scarcity of such technicians deters employers from making these the minimum educational requirements.

Inadequacies in the Education of Chemical Technicians

Employers of chemical technicians did not emphasize inadequacies in the areas of science and mathematics. Many employers did, however, indicate the need for greater skill in communications. If technicians have a post-high school education in the chemistry area with the appropriate level of math achievement, they have no difficulty in these areas. After employment, additional courses in mathematics and science may be taken through internal-training or tuition-refund programs.

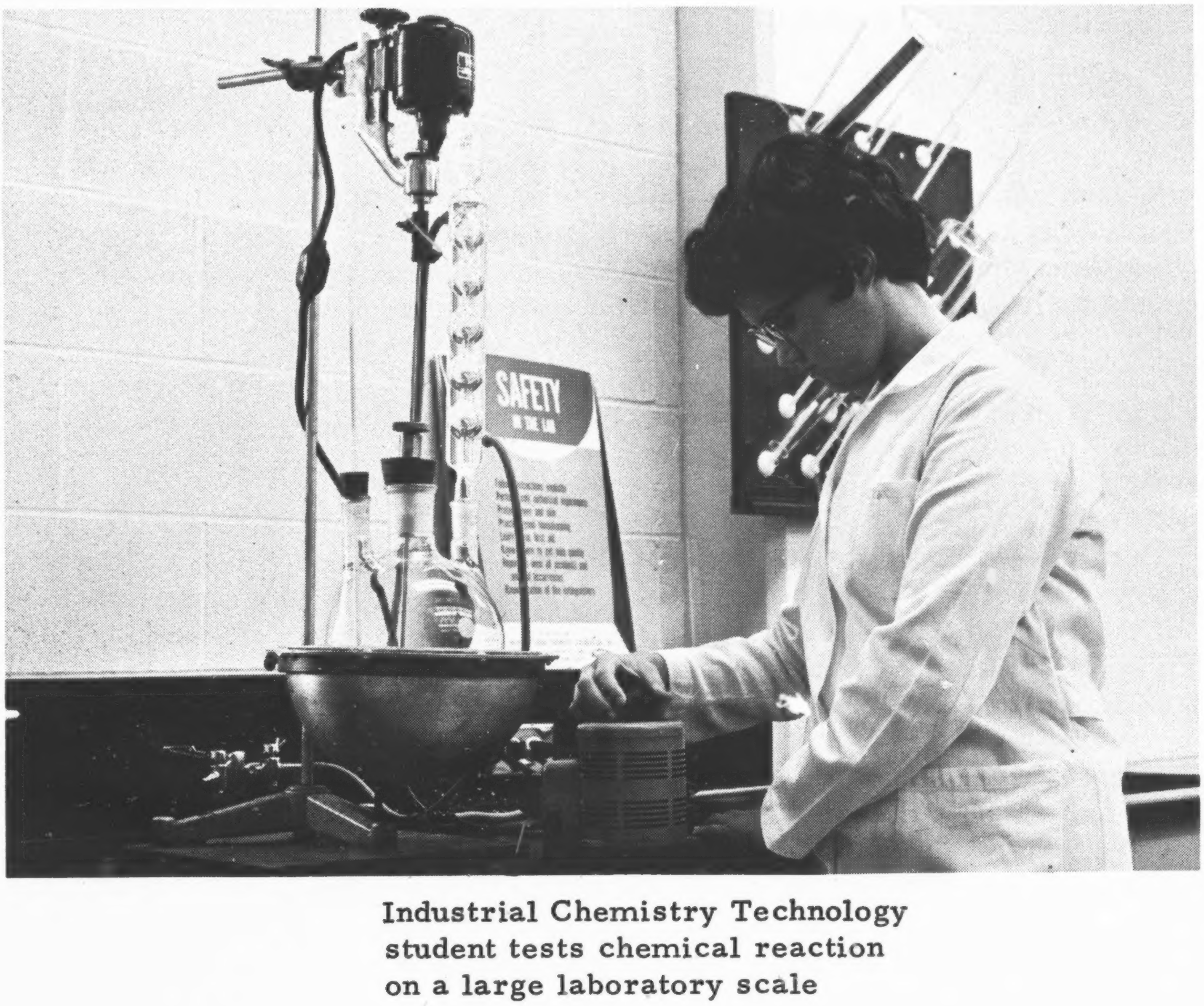
The most noticeable inadequacies as indicated by the employers are English and writing, particularly the writing of chemical reports. Additional instruction in report format, logical development, grammar and spelling is highly desirable.

It was mentioned often that chemical technicians need a broader perspective in the "world of work." Many technicians lack an understanding of the relation of their work to that of personnel in other departments or divisions. Courses in industrial relations and psychology might correct this deficiency.

In firms which employ small numbers of chemical technicians to do quality control work, it is desirable for technicians to have some background in statistical analysis. The benefit of a course in industrial safety for all chemical technicians was also mentioned.

Training Opportunities

The training opportunities for chemical technicians may be classified as 1) opportunities prior to employment and 2) opportunities while employed. Opportunities to prepare for employment as a chemical technician are offered by community colleges and four-year colleges with two-year occupational programs. For individuals employed at less than a technician level, certain large chemical manufacturers offer a formal internal upgrading program in which the instructors are company personnel. In addition, various size firms using chemical technicians have tuition-refund programs whereby individuals are reimbursed part or all of the cost for work-related courses taken at educational institutions. These out-service courses supplement the company training program.



Industrial Chemistry Technology
student tests chemical reaction
on a large laboratory scale

Seven post secondary educational institutions offer chemistry programs which are appropriate for preparing chemical technicians. (One of these schools offers two applicable programs bringing the total number of programs to eight.) In September, 1966, the combined enrollment for the eight programs was 198 students. The dimensions of the employer's problem in finding qualified technicians is apparent when this 198 is measured against present vacancies and projected needs for 1970.

Listed programs in college bulletins and catalogues are not indicative of all offerings that are available at the present time. Some of the programs are inoperative. Changes are planned to make two-year industrial chemistry technology programs more occupational in emphasis. Some of the programs have lacked enrollment as occupational programs because the emphasis was more in the nature of the first two years of a four-year program. Therefore, special industrial applications were not emphasized to develop technical skill desired by industry or to develop student interest. Also, there is insuffcent publicity given to the occupational opportunities of chemical technicians.

In the future there will be more educational programs for chemical technicians. Twelve additional educational institutions are planning curricula in the chemical area. However, the problem does not appear to be the number of programs available and therefore it may not be solved by this action. Rather, the problem is the limited number of students enrolled in existing two-year chemical technology programs. These programs demand a high degree of capability and aptitude. They are not programs for the "less able." In essence, these programs are open to students capable of obtaining a Bachelor's degree but who for personal or financial reasons desire a more immediate goal.

When the number of technicians with post-high school education is insufficient to meet the employer's needs, firms have the alternative of doing their own training. If the firm is large enough, and the demand for chemical technicians is great enough, the firm may provide a formal upgrading program. When the need is less demanding or the cost is prohibitive, the firms have depended upon informal on-the-job training and tuition-refund programs to fill the needs for technicians.

General Comments

The following comments were made by employers of large numbers of chemical technicians:

"Would just as soon hire the top man in a two-year program even when he states he will be returning to school."

"Not looking for a specific label in curriculum or subject matter concentration. The size of our company permits flexibility in recruitment. We are primarily concerned with ability and attitude."

"We simply need more and better ones." (technicians)

"There is a need for the type of preparation which will enable the individual to more readily transfer his laboratory experience in the school situation to the industrial laboratory where he finds employment."

"It should be strongly emphasized in counseling and school bulletins, that there is a very definite need for a two-year graduate."

FOOTNOTE REFERENCES

[1] J. Dennis Griffin, "Experience with Technicians in Industrial Research Laboratories", Research Management, Volume VIII, Number 6, Publication of the Industrial Research Institute, Incorporated (New York: John Wiley, November, 1965). pp. 347-358.

[2] Manufacturing Chemists Association, A Bright Future For You As A Chemical Technician. A Pamphlet prepared by Director of Education (Washington, D. C.: Manufacturing Chemists Association, 1966.)

[3] Griffin, op. cit., p. 349.

CHAPTER V

TECHNICIAN OCCUPATIONS WITHIN THE MECHANICAL RELATED FIELD

Technicians in the mechanical related field are employed in a wide variety of firms. Any firm utilizing or producing either stationary or movable machinery employs mechanical technicians. This includes manufacturers of many types of products.

Mechanical technicians include: optical technicians, mechanical-engineering technicians, and technicians concerned with repairing and maintaining machines. This study makes a distinction in the latter classification based on the type of equipment on which the technician specializes. Movable machines (cars, trucks, tractors, etc.) are the specialty of mechanical maintenance men.

The maintenance technician differs from the mechanical maintenance man in that he specializes in stationary machines. The Dictionary of Occupational Titles defines the maintenance technician's functions as: investigate cause of mechanical failures of operation and maintenance equipment and recommends corrective measures; studies shop records to determine frequency of failures. In this definition, the Dictionary of Occupational Titles does not mention that the maintenance man repairs equipment. In the firms interviewed, the technicians specializing in stationary equipment not only diagnose the difficulty, but in most cases do the repair work themselves.

There were other difficulties in identifying the technicians concerned with maintenance and repair of equipment. All of the definitions used in the study are based on job functions and the educational preparation necessary to perform these functions. Frequently, the job functions in the mechanical related area are performed by skilled craftsmen at the journeymen level. Their on-the-job training and related instruction are obtained through an apprentice program.

An analysis of the related instruction schedules for apprentice training programs revealed that many of these programs are of a sufficiently high level to consider a journeyman as a technician. This statement is particularly applicable to the industrial apprentice training programs. The apprentice receives, in addition to hours of "hands-on" experience, many hours of related instruction in mechanical theory and mathematics. The apprentice training programs for machine repair, diesel engine and heavy equipment, and automotive maintenance are closely related to the definitions used for mechanical maintenance man and maintenance technician. Portions of the apprentice program for millwright are related to the definition for maintenance technician. In some cases, the related training is taken at a community college and the apprentice receives college credit.

Manufacturing Technology student
with instructor
on numerical control milling machine
in community college shop

The pneumatic tester and mechanic works with pneumatic units such as valves, pumps, and regulators. After starting this Study, it was apparent that pneumatic tester and mechanic was a poor selection for inclusion. Impressions received from interviewees indicated hydraulic tester or hydraulic and pneumatic tester and mechanic as a more appropriate occupational title for inclusion.

The air-conditioning mechanics are classified by the size and type of unit they work -- domestic or commercial. The firms interviewed, because of the type of business did not reveal significant findings regarding mechanics and work on domestic units. In some interviews, the mechanics were classified under domestic because of the job definition provided by the employer regarding the level and difficulty of the type of work performed.

The decision to include or exclude a journeyman from a technician classification was made by the employer based on the job functions the employee performed. Some large employers, refuse to recognize as technicians, the hourly rated employee in the bargaining unit regardless of the job functions performed or educational experience and skill development.

Present Employment, Present Vacancies, and Projected Needs for 1970

In the firms interviewed, there are presently 6,890 mechanical-related technicians employed with job vacancies for 566 more. Employers interviewed anticipate they will need an additional 1,677 mechanical-related technicians by 1970, bringing the total to 9,133. Table 7 presents the detailed breakdown for mechanical-related technicians in the firms interviewed.

TABLE 7

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS FOR TECHNICIANS IN THE MECHANICAL-RELATED FIELD[a]

Classification	Presently Employed	Present Vacancies	Total Projected Employment 1970
1. Optical Technician	13	—	20
2. Mechanical-Engineering Technician	3,192	175	3,953
3. Mechanical Maintenance Technician	1,623 (3)	119	2,167 (3)
4. Pneumatic Tester and Mechanic	78	8	122
5. Air-Conditioning Mechanic (Domestic)	27	9 (1)	148 (1)

TABLE 7 (Cont'd)

Classification	Presently Employed	Present Vacancies	Total Projected Employment 1970
6. Air-Conditioning Mechanic (Commercial)	109	8	187
7. Maintenance Technician	1,405 (9)	154	1,845 (12)
8. Unclassified Mechanical-Related Technicians	443	93	691
TOTAL	6,890	566	9,133

a. The figures in parenthesis represent the number found in hospitals for the appropriate occupational titles. The total figures for each occupational title include those in parenthesis.

The information presented in Table 8 indicates a wide range of employment opportunities for certain classifications, especially Mechanical Engineering Technicians and Mechanical Maintenance Men. The most significant percentage under some occupational titles is indicated as being employed in the transportation equipment field, SIC 37. Particular attention should be paid to the fact that for purposes of this report, the automotive industry has been classified under SIC 37, transportation equipment. This classification was used because all information was furnished by a central office without specific breakdowns by SIC codes for divisions. Whereas, in fact, their divisions manufacture a number of products and some divisions are actually listed under a SIC code other than 37. Where the percentage of total employment for any occupational title by Standard Industrial Classification (SIC) code is less than five percent, the data are grouped and the combined percentage figure reported.

TABLE 8

DISTRIBUTION OF TECHNICIAN EMPLOYMENT BY CLASSIFICATION OF FIRMS

Occupational Title	Classification of Firm (s) Employing Occupational Title	SIC Code (s	Percent of Total Employment for Occupational Titles by SIC
1. Optical Tech.	Various (See Appendix A, Part 1)	19, 33	12.50

TABLE 8 (Cont'd)

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Title by SIC
	Machinery (Except Elec.)	35	31.25
	Electrical Machinery	36	12.50
	Instruments & Related	38	43.75
2. Mechanical Engineering Technician	Various (See Appendix A, Part 1)	16, 17, 19, 20, 23, 25, 26, 27, 28, 30, 32, 33, 34, 36, 38, 39, 49, 82, 89	20.62
	Machinery (Except Elec.)	35	13.40
	Transportation Equipment	37	65.98
3. Mechanical Maintenance Man	Various (See Appendix A, Part 1)	14, 15, 17, 20, 23, 25, 26, 27, 28, 30, 32, 34, 36, 50, 54, 89	17.38
	Metal Mining	10	5.27
	General Contractors (Except Buildings)	16	5.64
	Primary Metal	33	14.13
	Machinery (Except Elec)	35	8.12
	Transportation Equipment	37	18.66
	Trucking Warehousing	42	9.73
	Electric, Gas, and Sanitary Service	49	6.51
	Automotive Dealers and Service Stations	55	14.19
4. Pneumatic Tester and Mechanic	Various (See Appendix A, Part 1)	20, 30, 34, 36	13.33
	Petroleum and Coal	29	10.67
	Machinery (Except Elec.)	35	13.33
	Transportation Equipment	37	62.67

TABLE 8 (Cont'd)

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code	Percent of Total Employment for Occupational Title by SIC
5. Air-Conditioning Mechanic (Domestic)	Various (See Appendix A, Part 1)	20, 36, 50	12.82
	Special Trade Contractors	17	33.33
	Machinery (Except Elec.)	35	23.08
	Electric, Gas, and Sanitary Service	49	30.77
6. Air-Conditioning Mechanic (Commercial)	Various (See Appendix A, Part 1)	26, 33, 36 49	5.03
	Special Trade Contractors	17	30.19
	Machinery (Except Elec.)	35	15.09
	Transportation Equipment	37	22.00
	Food	54	11.95
	Miscellaneous Services	89	15.72
7. Maintenance Technician	Various (See Appendix A, Part 1)	14, 17, 20, 24, 25, 27, 28, 29, 30, 31, 32, 36 39, 48, 50 60, 63, 89	13.41
	Paper and Allied Products	26	5.56
	Primary Metal	33	22.86
	Fabricated Metal	34	7.16
	Machinery (Except Elec.)	35	11.47
	Transportation Equipment	37	39.54

Projections for all firms meeting the criteria have been carefully considered. It was not considered appropriate to make projections for firms not meeting the criteria; that is, the firms with less than a predetermined number of employees for their particular type (SIC code). On the basis of information obtained from firms interviewed, estimates of need are shown in Table 9 for like firms meeting the criteria as to number of employees. (See Appendix A, Part 1).

TABLE 9

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE MECHANICAL-RELATED FIELD, 1970[a]

Classification	Estimates of Occupational Need		
	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. Optical Technician	20	12	32
2. Mechanical Engineering Technician	3,953	268	4,221
3. Mechanical Maintenance Man	2,167	1,456	3,623
4. Pneumatic Tester and Mechanic	122	9	131
5. Air-Conditioning (Domestic)	148	97	245
6. Air-Conditioning (Commercial)	187	343	530
7. Maintenance Technician	1,845	265	2,110
8. Unclassified Mechanical-Related Technician	691	d	691
TOTAL	9,133	2,450	11,583

a. Data includes only those needs of employers who met criteria for inclusion in the study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers as shown in Table 7.

c. Computed. (See Appendix A, Part 7, for method of computation.)

d. No estimates have been projected for the unclassified category of mechanical technicians.

Minimum Educational Requirements

The majority of mechanical-related technicians are or have been journeymen who receive their training in an apprentice program. A few mechanical-related technicians received their education at a post-high school technical institute. Most large and medium sized firms require as a minimum that technicians in the mechanical-related field, excluding optical technicians and mechanical-engineering technicians, go through a four to five year apprenticeship. The minimum educational requirement for entry into the apprentice program is a high school education or the equivalent.

A few firms will employ mechanical-related technicians who have only a high school education. Employees who have only a high school education usually receive formal or informal on-the-job training after employment. Through this practical experience, they eventually reach the level of a technician. In classifications other than those in the bargaining unit, the minimum educational requirement is frequently a high school education plus work experience. Firms which were not able to fill positions following these lines were forced to lower their minimum requirement to high school completion only.

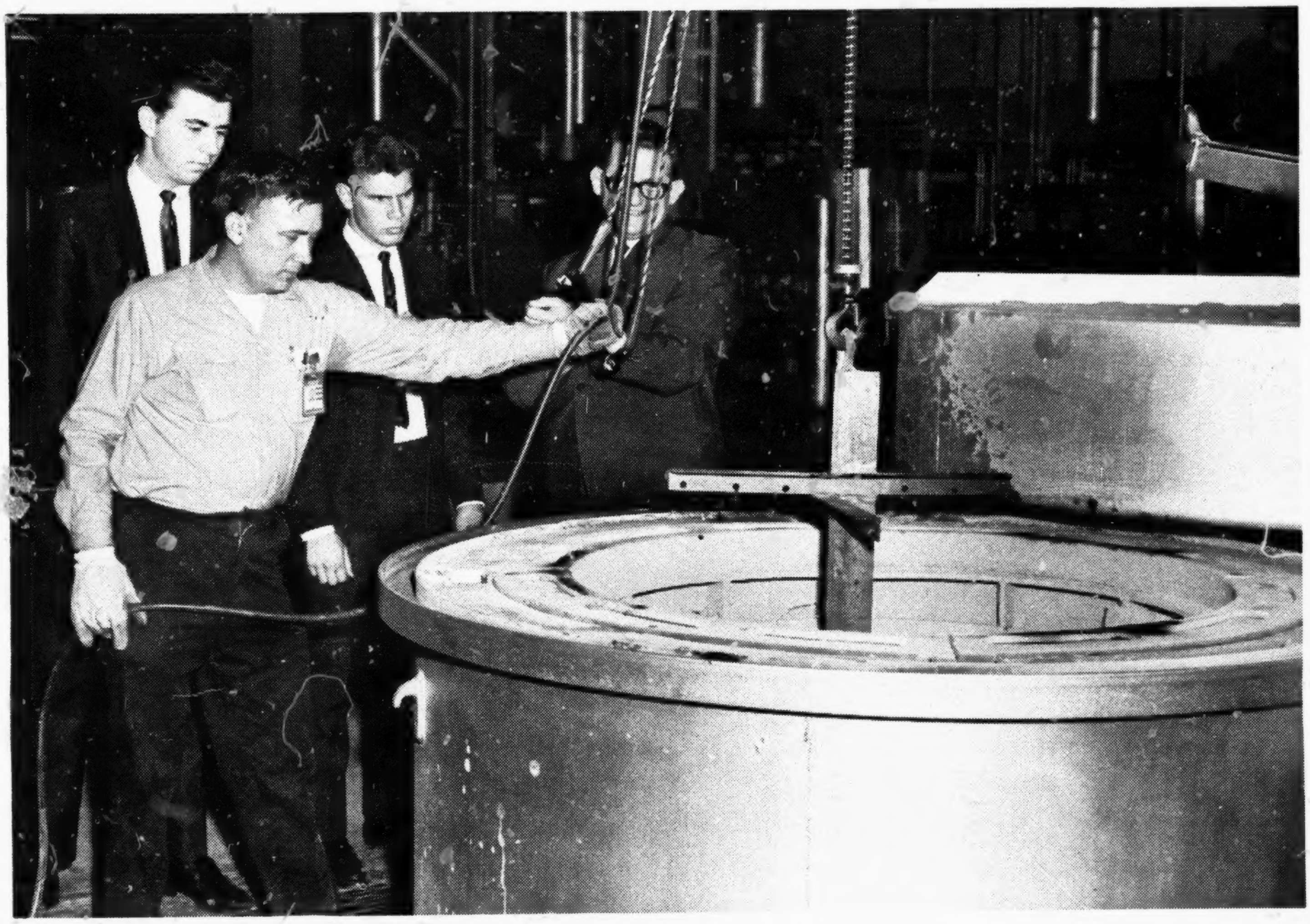
Preferred Educational Requirements

Most of the employers interviewed prefer that technicians in the mechanical-related field have some post-high school technical training at either public or private institutions offering two-year technical programs. Some of the mechanical-related technicians, such as maintenance technicians and mechanical maintenance men are required to complete an apprenticeship or other organized training program because these positions are often in the bargaining unit. The employers believe arrangements might be made to give some credit for technical training received outside the apprentice program. In some cases, a post-high school technical program offers an advantage to aspiring apprentices because the apprentice entrance examination is so rigorous.

Large corporations, having a minimum educational requirement for mechanical-engineering technicians and optical technicians of post-high school technical training, prefer that applicants have work experience prior to employment.

Inadequacies in the Education of Mechanical Technicians

Employers of mechanical-related technicians indicate that educational institutions are not meeting the demand. It is possible that the presence of apprentice training programs has discouraged schools from developing more such programs. Many public institutions provide the related instruction courses for apprentices and in this way offer some aid for employers and assist students wishing to enter the mechanical-related area.



Cooperative Students
in Mechanical Technology
at a community college
are introduced
to Heat-Treating Process

The major educational inadequacies of mechanical-related technicians in the firms interviewed, as stated by employers, are English and writing. These technicians need more background in communications, both written and verbal. The technician should learn how to present data. Many interviewees have had little exposure to mechanical technicians with formal post-high school education. For this reason, they hesitate to state specific inadequacies. They did, however, point out that mechanical-engineering technicians would need mathematics through trigonometry including solid, plane, and descriptive geometry. Technicians in this classification also must have a concentration of courses in the physical and mechanical sciences that include both the theoretical and practical aspects of these disciplines.

The auto service industry, which makes extensive use of mechanical maintenance men, sees a need for more exposure to advanced diagnostic and testing methods. In the areas of product testing, automotive manufacturers can utilize effectively persons with mechanical maintenance training when combined with elements of instrumentation.

Both mechanical-engineering technicians and maintenance technicians must keep abreast of developments in numerical control. Courses pertaining to this area should be incorporated in their educational programs. The publication, Outlook for Numerical Control of Machine Tools states, "Numerical control requires additional knowledge of servomechanisms, electronics, and numerical control systems--and responsibility for much more highly priced equipment."[1] The influence of numerical control blurs the line of distinction between the electronics mechanic and the maintenance man. Possibly, a core-curriculum including numerical control should be provided for these and other technical classifications.

The maintenance of automatic machinery usually requires a retraining of present employees. Future employees should have a higher degree of both skill development and education. One writer examined such requirements by relating them to job content. In conclusion, he qualifies the need for maintenance men and operators for more extensive training.[2]

During the study, one training program was examined that relates maintenance personnel duties to the training required for repair of numerical control equipment. From the user point of view, this program has very little special training required on mechanical repair; instead, the training places emphasis on needs in electrical and hydraulic repair work. The principal training emphasis by the employer is on numerical processing and the need for training by employees that operate the equipment. Considerable reliance, at present, is placed on the equipment manufacturers or training manuals and servicing. However, many employers anticipate that in the future, the user of the numerical control machinery will have to provide more training for their employees who maintain the mechanical aspects of the equipment. Also, a majority of the interviewees employing technicians in the mechanical-related classifications encourage curriculum planners to include courses pertaining to the business world--such as, business administration and economics. They indicated too that technicians are frequently ill-prepared to take their place in business because they lack a picture of the whole and fail to understand the interdependence of various job functions; that cooperative programs are very beneficial in over-coming such deficiencies; and that a course in industrial relations would be beneficial for technicians in the mechanical-related field because of the many apprentice programs in this area and the number of technicians in the bargaining unit.

Training Opportunities

The training opportunities for mechanical technicians are many and varied. The demand for such people has necessitated using all avenues possible: apprentice programs, post-secondary public and private educational institutions, tuition-refund programs, and inservice training programs. A majority of the present mechanical technicians received their training in a formal apprentice program. As mentioned previously, some of the mechanical technician classifications are in the bargaining unit and the technicians are journeymen. These technicians reached their present position after receiving training in the apprentice program and gaining experiences on the job. Exceptions to this process are the mechanical-engineering technicians and the optical technicians.

Most medium and large sized firms offer apprentice training programs in the mechanical-related area, especially in the occupational classifications related to machine trades and manufacturing trades. The apprentice programs vary in length from 8,000 clock hours to 10,000 clock hours, with the majority of the programs requiring 8,000 clock hours. Related instruction courses are included in these programs. The formal class instruction may be conducted by the participating firm or offered by a public post-secondary school. The time devoted to the related instruction varies from 572 hours to 672 hours, over a four year period. The Bureau of Apprenticeship and Training recommends a minimum of 572 hours of related instruction.[3] The 144 hours annual minimum has been adjusted upward to meet specific apprentice training program requirements and also to relate more realistically with instruction time required for the more difficult related subjects.

The instruction, by definition, is closely related to the on-the-job work requirements. Many community colleges provide the necessary courses. In some cases, college credit is given for the courses successfully completed by the apprentice. These credits can be applied toward an Associate degree. Eight of the ten community colleges providing related instruction give college credit. The schedules for the related instruction were furnished either by the college or the employer.

The related instruction provides the theoretical courses for the practical on-the-job experiences. This includes math, metal processes, blue-print reading, physics, electrical (AC and DC) courses and other specialty courses.

Some post-secondary schools offer Associate degree programs in the mechanical-related area. Most mechanical-engineering technicians receive their training in this manner. There are also several programs for mechanical maintenance men, particularly the type used in auto service firms.

In the fall of 1966, 33 post-secondary programs were in existence with a combined enrollment of 2,013 students. Twenty-two more programs are planned. A private school offers programs in the mechanical-related area.

Mechanical technicians may also receive some training through internal training programs sponsored by firms and through tuition-refund programs. In these ways, technicians have an opportunity to take refresher courses or learn new skills.

General Comments

'There is a very critical shortage of refrigeration technicians."

"Apprentice programs do train a fellow to be a mechanic but this does not prepare them for advancement into leadership positions."

"We have had extremely bad luck finding two year graduates with training in automotive air-conditioning technology."

"Air-Conditioning technicians have to do work with heating systems as well as cooling systems."

"We would like to see more courses in machine repair with courses available to employed persons."

"We have difficulty in getting mechanics. Mechanics must be training now or in 15 years there won't be any." (auto-service establishment)

"Would like to see more formal training in the mechanical area. I believe the mechanical trade schools with cooperative programs are good. The cooperative program should be one month on the job and one month in school."

FOOTNOTE REFERENCES

[1] Bureau of Labor Statistics, United States Department of Labor, Outlook for Numerical Control of Machine Tools, Bulletin 1437 (Washington: Government Printing Office, 1965), p. 3.

[2] James R. Bright, "The Relationship of Increasing Automation and Skill Requirements", Technology and the American Economy, Appendix, Volume II, The Employment Impact of Technological Change (Washington: Government Printing Office, 1966), pp. II 207-II 221.

[3] Bureau of Apprenticeship and Training, United States Department of Labor, JATC Handbook (Washington: Government Printing Office, 1962), p. 6.

CHAPTER VI

TECHNICIAN OCCUPATIONS WITHIN THE DRAFTING AND DESIGN RELATED FIELD

All technicians within this area must be capable of preparing clear, complete, and accurate working plans and detailed drawings from rough or detailed sketches or notes for engineering or manufacturing purposes, according to specified dimensions. Draftsmen and designers with these general abilities were classified in the study according to their area of specialization such as Electrical Draftsman or Civil Draftsman. There is a direct relationship between the draftsman's specialty and the type of industry in which he is employed. For example, the majority of Aeronautical Draftsmen are employed in firms classified as Ordnance and Accessories (SIC 19).

In this study, the definition for Product Draftsman has a very broad application. It includes all draftsmen directly concerned with the firm's product regardless of the type of firm or type of product. The exception would be products requiring a classification in a specialized area. Work pertaining to mechanical products predominate in this classification, but the Product Draftsman usually performs more sophisticated and specialized work than the Mechanical Draftsman. Usually, mechanical drafting is an entry position, whereas product drafting and design requires years of experience with a particular product. The Product Draftsman is differentiated by sub-classifications when this is appropriate as indicated by the job functions assigned by a firm. The sub-classifications of Product Draftsman are: Die Designer, Lay-Out Draftsman, Industrial Designer, and Tool Designer. Job Functions from the Dictionary of Occupational Titles were arranged to obtain the desired information. The job functions of Product Draftsman used in the study are from the Dictionary of Occupational Titles definition of Industrial Designer, Product Designer. The job functions of Industrial Designer used in the study are from the Dictionary of Occupational Titles definition of Engineering Assistant, Mechanical Equipment. (See Appendix A, Part 3-b.) This arrangement was based upon preliminary interview findings in which it was found that employers were having difficulty classifying draftsmen.

Present Employment, Present Vacancies, and Projected Needs for 1970

In the firms interviewed, 13,464 draftsmen are presently employed. There are present vacancies for 2,178 draftsmen. By 1970, an additional 5,372 draftsmen will be needed, bringing the projected 1970 employment to 21, 014 draftsmen. Attrition is not considered in the projections. The Michigan Manpower Study projects less than this number for total draftsman employment in 1980. However, this report does emphasize that there are "a number of uncertainties associated with new technologies that are repidly being developed and which affect the functions of the draftsman."[1]

The statistical information in this report is considered to be on the conservative side. During the collection of information for the Technician Need Study in Michigan, the figures for large corporations were obtained from their central office. Such figures represent the statistical information incorporated into this report. However, there were occasions when visits at the division level revealed more draftsmen employed than reported by the corporate central office for their total Michigan employment in the particular occupational classification. Table 10 presents the detailed breakdown for draftsmen and other design related technicians in the firms interviewed.

TABLE 10

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS FOR TECHNICIANS IN THE DRAFTING AND DESIGN-RELATED FIELD

Classification	Presently Employed	Present Vacancies	Total Projected Employment 1970
1. Architectural Draftsman	489	94	735
2. Aeronautical Draftsman	16	27	161
3. Electronic Draftsman	110	32	267
4. Electrical Draftsman	419	120	756
5. Structural Draftsman	196	47	326
6. Civil Draftsman	81	16	131
7. Product Draftsman(n. e. c.)	4, 233	487	5, 888
a. Die Designer	387	90	727
b. Lay-Out Draftsman	693	186	1, 212
c. Industrial Designer	962	118	1, 319
d. Tool Designer	1, 003	268	2, 272
8. Mechanical Draftsman	3, 373	545	5, 059
9. Mine Draftsman	46	10	108
10. Marine Draftsman	21	0	23
11. Oil & Gas Draftsman	62	13	106
12. Air-Conditioning, Plumbing and Heating Draftsman	125	47	247

TABLE 10

Classification	Presently Employed	Present Vacancies	Total Projected Employment 1970
13. Map Draftsman	39	4	52
14. Unclassified Draftsman	1,209	74	1,625
TOTAL	13,464	2,178	21,014

The information presented in Table 11 indicates that there is a wide variety of employment opportunities, especially for Mechanical Draftsmen. The most significant percentage under the occupational classification of Product Draftsman and the subtitles listed thereunder is indicated as being employed in the transportation equipment field, SIC 37. Particular attention should be paid to the fact that for purposes of this report, the automotive industry has been classified under SIC 37, transportation equipment. This classification was used because all information was furnished by a central office without specific breakdowns by SIC codes for divisions. Whereas, in fact, their divisions manufacture a number of products and some divisions are actually listed under a SIC code other than 37. Where the percentage of total employment for any occupational title by Standard Industrial Classification (SIC) was less than five per cent, the types of firms are grouped and the combined percentage figure reported.

The distribution of employment of Draftsmen in Michigan should be of interest to curriculum planners in the post-secondary educational institutions. The subjects and skill training emphasis would vary considerably from primary needs in other states; for example, New York. In the New York study, the largest concentration of draftsmen were found in engineering and architectural firms.[2]

Cooperative students
from Community College Drafting Program
in Industrial Services activity
of Michigan manufacturer

TABLE 11

DISTRIBUTION OF TECHNICIAN EMPLOYMENT BY CLASSIFICATION OF FIRMS

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code (s)	Percent of Total Employment for Occupational Titles by SIC
1. Architectural Draftsman	Various (See Appendix A, Part 1)	17, 25, 26, 28, 29, 33, 38, 50, 60, 73	7.95

TABLE 11(Cont'd)

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
	General Contractors	15	6.07
	Fabricated Metal	34	16.74
	Transportation Equipment	37	11.51
	Miscellaneous Services	89	57.74
2. Aeronautical Draftsman	Various (See Appendix A, Part 1)	25, 73	10.00
	Ordnance & Accessories	19	55.00
	Chemical&Allied Products	28	20.00
	Machinery(Except Elec.)	35	15.00
3. Electronic Draftsman	Various (See Appendix A, Part 1)	19, 28, 34, 39	12.50
	Furniture & Fixtures	25	7.50
	Machinery(Except Elec.)	35	18.33
	Electrical Machinery	36	34.17
	Transportation Equip.	37	11.67
	Instruments & Related	38	6.67
	Miscellaneous Services	89	9.17
4. Electrical Draftsman	Various (See Appendix A, Part 1)	10, 14, 15, 17, 20, 28, 30, 32, 33, 34, 73	8.98
	Machinery(Except Elec.)	35	21.99
	Electrical Machinery	36	8.75
	Transportation Equip.	37	27.66
	Miscellaneous Services	89	32.62
5. Structural Draftsman	Various (See Appendix A, Part 1)	10, 15, 20, 26, 28, 33, 37, 49, 59, 73	12.89
	Fabricated Metal	34	19.11
	Machinery(Except Elec.)	35	27.11
	Electrical Machinery	36	7.11
	Miscellaneous Services	89	33.78

TABLE 11(Cont'd)

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
6. Civil Draftsman	Various (See Appendix A, Part 1)	14, 15, 16, 25, 28, 32, 33, 35, 37, 73	24.00
	Electric, Gas & Sanitary	49	20.00
	Miscellaneous Services	89	56.00
7. Product Draftsman (n. e. c.)	Various (See Appendix A, Part 1)	17, 25, 26, 30, 33, 34, 35, 36, 38, 39	10.58
	Transportation Equipment	37	71.36
	Miscellaneous Services	89	18.06
7a. Die Designer	Various (See Appendix A, Part 1)	25, 30, 32, 33, 36	3.42
	Fabricated Metal	34	6.05
	Machinery (Except Elec.)	35	12.63
	Transportation Equipment	37	65.53
	Miscellaneous Services	89	12.37
7b. Lay-Out Draftsman	Various (See Appendix A, Part 1)	15, 19, 20, 22, 25, 28, 31, 33, 34, 36, 38, 39, 48	12.48
	Machinery (Except Elec.)	35	48.98
	Transportation Equipment	37	8.55
	Miscellaneous Services	89	29.99
7c. Industrial Designer	Various (See Appendix A, Part 1)	17, 20, 25, 28, 30, 32, 33, 34, 36	6.71
	Machinery (Except Elec.)	35	16.10
	Transportation Equipment	37	43.03
	Electric, Gas & Sanitary	49	10.53
	Miscellaneous Services	89	23.63

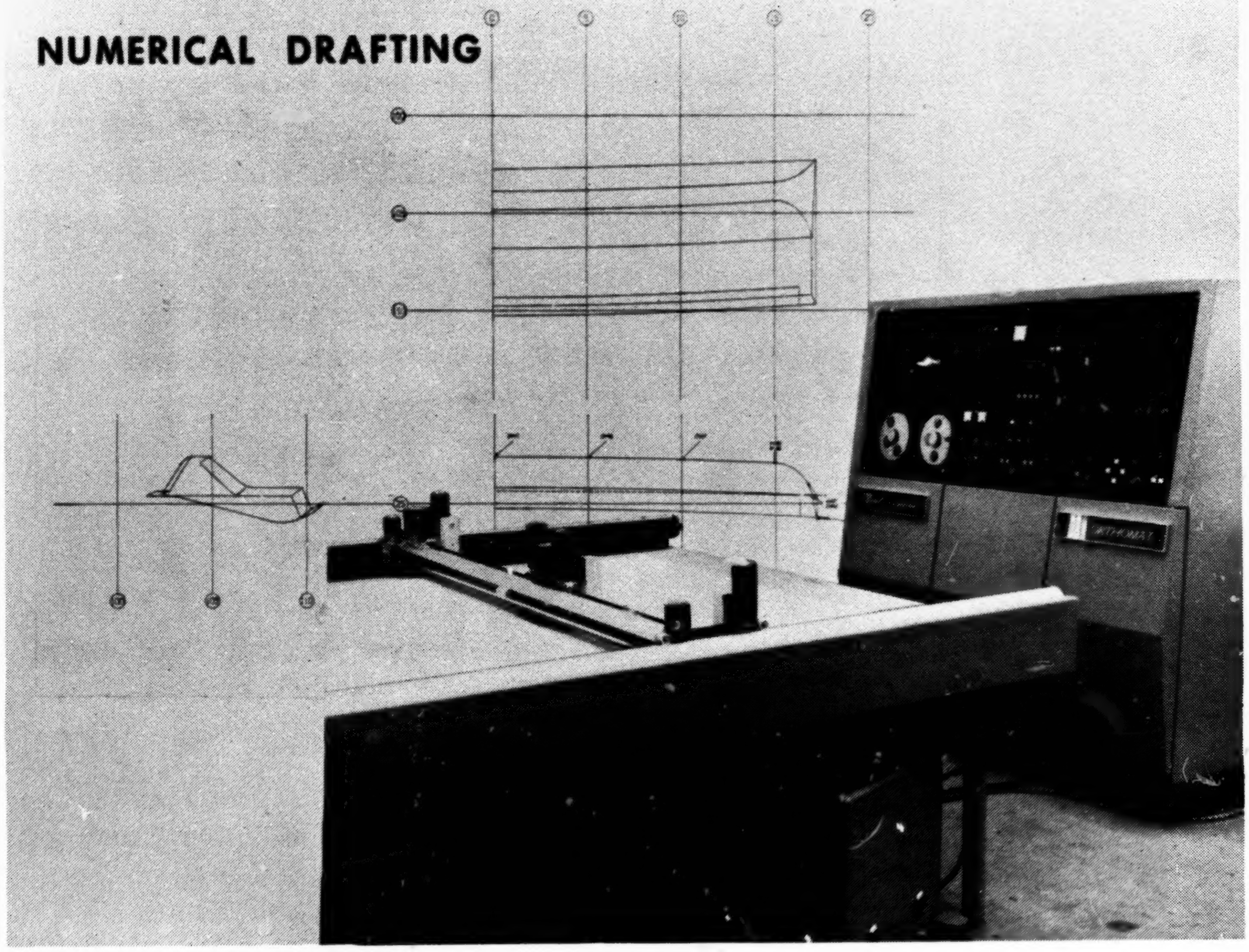
TABLE 11(Cont'd)

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
7d. Tool Designer	Various (See Appendix A, Part 1)	19, 25, 28 30, 32, 33, 34, 36, 38, 39	18.07
	Machinery(Except Elec.)	35	16.91
	Transportation Equip.	37	10.71
	Miscellaneous Services	89	54.31
8. Mechanical Draftsman	Various (See Appendix A, Part 1)	10, 15, 16, 17, 19, 20, 23, 25, 26, 28, 30, 32, 33, 38, 39, 73, 82	7.50
	Fabricated Metal	34	6.15
	Machinery(Except Elec.)	35	29.77
	Electrical Machinery	36	8.70
	Transportation Equip.	37	22.50
	Miscellaneous Services	89	25.90
9. Mine Draftsman	Metal Mining	10	13.04
	Miscellaneous Services	89	86.96
10. Marine Draftsman	Transportation Equip.	37	100.00
11. Oil & Gas Draftsman	Miscellaneous Services	89	3.23
	Petroleum & Coal	29	11.29
	Electric, Gas & Sanitary	49	85.48
12. Air-Conditioning & Heating Draftsman	Various (See Appendix A, Part 1)	28, 38	3.25
	Special Trade Contractors	17	11.38
	Machinery(Except Elec.)	35	5.69
	Transportation Equipment	37	17.07
	Miscellaneous Services	89	62.60

TABLE 11 (Cont'd)

Occupational Title	Classification of Firm (s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
13. Map Draftsman	Insurance Carriers	63	3.85
	Communication	48	34.62
	Electric, Gas & Sanitary	49	42.31
	Miscellaneous Business Services	73	7.69
	Miscellaneous Services	89	11.54

It is evident from the detailed breakdown that Product Draftsmen and Mechanical Draftsmen are the dominating occupational titles. The majority of draftsmen are employed in manufacturing or engineering and architectural services. The future demands for draftsmen may be drastically affected by numerical control adaptations. Developments in this area were mentioned by interviewees, and the subject is discussed in Outlook For Numerical Control Of Machine Tools published by the Bureau of Labor Statistics.[3] The projections incorporated in this study were supplied by firm representatives and very few interviewees anticipated a decline in the demand for draftsmen within the next four to five years. Beyond that point, numerical control may be more influential on needs for draftsmen.



Numerical Drafting Equipment
In Drafting Department
of Michigan Manufacturer

Projections for all firms meeting the criteria have been carefully analyzed. It was not considered feasible to make projections for firms that did not meet the criteria; that is, the firms had less than a predetermined number of employees for their particular type (SIC code). On the basis of information obtained from firms interviewed, estimates of need are shown in Table 10 for like firms meeting the criteria as to number of employees. (See Appendix A, Part 1.) No estimates have been projected for the unclassified category of draftsmen included in Table 10.

TABLE 12

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE DRAFTING AND DESIGN-RELATED FIELD, 1970[a]

Classification	Estimates of Occupational Need		
	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. Architectural Draftsman	735	2,234	2,969
2. Aeronautical Draftsman	161	496	657
3. Electronic Draftsman	267	340	607
4. Electrical Draftsman	756	160	916
5. Structural Draftsman	326	137	463
6. Civil Draftsman	131	99	230
7. Product Draftsman	5,888	149	6,037
a. Die Designer	727	316	1,043
b. Lay-Out Draftsman	1,212	341	1,553
c. Industrial Designer	1,319	241	1,560
d. Tool Designer	2,272	350	2,622
8. Mechanical Draftsman	5,059	614	5,673
9. Mine Draftsman	108	4	112
10. Marine Draftsman	23	10	33
11. Oil & Gas Draftsman	106	53	159
12. Air-Conditioning, Plumbing, & Heating Draftsman	247	100	347
13. Map Draftsman	52	32	84
14. Unclassified Draftsman	1,625	d	1,625
TOTAL	21,014	5,676	26,690

a. Data includes only those needs of employers who met criteria for inclusion in the Study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers as shown in Table 10.

c. Computed. (See Appendix A, Part 7, for method of computation.)

d. No estimates have been projected for the unclassified category of draftsmen.

Minimum Educational Requirements

In large corporations, draftsmen usually have some forms of post-high school training. It may be through an apprentice program, or it may be training received at a post-secondary technical institute or a community college prior to employment. The vacancies in draftsman classifications may be filled from within through promotion of journeymen classifications in the skilled trades. One large corporation requires up to two years of post-secondary technical training prior to entry into their most advanced training program in drafting (product design). Up to 2,000 hours of credit toward 8,000 hours of the training program may be granted for the prior related instruction and work experience connected with the training. Some draftsmen have had no formal training beyond high school, but have gained skill through practical experience.

Student of Drafting Board
for problem assignment
at a state college in Michigan

In other firms, the minimum educational requirement is high school graduation plus either formal or informal on-the-job training or prior job experience. Evidence of satisfactory achievement in two years of drafting at a high school level was acceptable to one firm employing high school graduates. Some engineering associations provide apprentice training programs in drafting for member firms. They are involved in the sponsorship and agreements for the program. At the time of the study, the short supply of draftsmen had caused many firms to lower their minimum requirements.

Preferred Educational Requirements

The general consensus of all firms interviewed was that they prefer draftsmen with one or two years of post-secondary training plus some job experience. Only one or two firms prefer draftsmen with four years of college. In addition to the post-secondary training, most large corporations prefer extensive work experience.

Inadequacies in the Education of Draftsmen

The high demand for draftsmen, and the corresponding lowering of hiring standards, has resuled in an increase of draftsmen lacking formal training. Most interviewees are satisfied with draftsmen who have some post-secondary training. They did, however, mention that educational institutions could improve drafting programs by the addition of cooperative work experience. They also felt draftsmen would benefit from technical courses in communications such as technical report writing and public speaking.

The draftsman who has no formal post-secondary training lacks both technical skill and the desired background in mathematics. These technicians should have courses in basic algebra, descriptive geometry, plane geometry, basic trigonometry, slide rule, and advanced trigonometry. It is also beneficial for draftsmen to be familiar with the machine shop and have some elementary experience with machine tools and parts. The draftsman's knowledge of the strength of various materials is also important.

Training Opportunities

Post-secondary educational institutions in Michigan presently offer 28 programs in the drafting area. In the fall of 1966, they had an enrollment of 2, 286 students in these programs. Ten more programs in drafting are planned. Besides the programs of the one private institution included in these figures, another private institution offers drafting programs, but no enrollment figures were furnished. Employers feel the co-operative drafting programs offered by educational institutions were excellent. Such experience greatly facilitates the occupational readiness of the graduate.

Cooperative Students
from Community College Drafting Program
in Plant Engineering Department
of Michigan Manufacturer

Apprentice training programs in drafting are provided by several large corporations. Most of the programs are 8,000 clock hours in length (about four years) including 672 hours of related work instruction. The length of the training period was five calendar years for one association-sponsored apprentice training program. The related instruction is usually given by a community college. In many cases, the apprentice receives college credit for these courses. Selection of candidates for the apprentice programs is based on tests of mathematical and mechanical aptitude.

For this reason, some training beyond the high school level may be very beneficial. A drafting program offered by a large corporation places emphasis on 1) orthographic projection, 2) drawing techniques, 2) geometrical contruction, and 4) sectional view.

General Comments

"In the drafting area, even after two years of technical education, a man must enter industry as a detailer and not as a designer. However, with formalized training he can move up quite rapidly."

"Adequately trained tool designers are the most difficult technicians to find."

"What is greatly needed is a drafting program which concentrates on hydraulic drafting. The firms which are involved with this have a very small supply of experienced draftsmen from which to draw."

"Draftsmen tend to be quite mobile. So much of their work is in job shops that an employer cannot hold on to them very long. Often, a bonus must be offered to the draftsman in order to keep him through the completion of a project."

FOOTNOTE REFERENCES

[1] Michigan Manpower Study: An Analysis of the Characteristics of Michigan's Labor Force in the Next Fifteen Years (Columbus, Ohio: Battelle Memorial Institute, November, 1966), p. 78.

[2] New York State - Department of Labor, Division of Research and Statistics, Technical Manpower in New York State, Special Bulletin 239, Volume II (December, 1964), p. 1.

[3] Bureau of Labor Statistics, United States Department of Labor, Bulletin 1437, Outlook for Numerical Control of Machine Tools (Washington: Government Printing Office, 1965), p. 40.

CHAPTER VII

TECHNICIAN OCCUPATIONS WITHIN THE ELECTRICAL AND ELECTRONIC RELATED FIELD

Present Employment, Present Vacancies, and Projected Needs for 1970

Rapid growth and expansion of electrical and electronic related occupations are to be expected as firms adopt new automated techniques and equipment. The classifications of technicians in this group range from electrical and electronic technicians to instrumentation and automatic equipment technicians. Technicians in the electrical and electronic area are utilized in production of electrical and electronic equipment, in operational and environmental testing, and in the maintenance of electrical and electronic equipment. These technicians are working in virtually all types of industry. All large manufacturers utilize some electrical and electronic technicians.

Occupational definitions from the Dictionary of Occupational Titles were not followed consistently to classify the technicians employed and needed in the electrical and electronic field. For example, during the study, the definitions for instrumentation technician and automatic equipment technician classifications were listed under the heading of "Miscellaneous."

It was later recognized that instrumentation technician should have been grouped with electrical and electronic related occupations. The employer more readily could have compared it with the electro-mechanical definition to provide more opportunity for distinction between the two. It was noted that in the New York study, the electro-mechanical definition is similar to the instrumentation technician definition from the Dictionary of Occupational Titles.[1] The occupational titles "Instrumentation Technician" and "Automatic Equipment Technician" are listed in this section of this report.

In the report of the New York state study, Technical Manpower in New York State, the electrical and electronic related positions were classified in three ways: 1) field of engineering, 2) functions performed, and 3) products or equipment worked on. The fields were broken down into two sub-areas for electrical and two sub-areas for electro-mechanical.[2]

However, in this Technician Need Study for the State of Michigan, it was determined that the definitions used would elicit sufficiently accurate information to enable curriculum developers to relate course emphasis to employer needs.

There are 3, 790 technicians employed in the firms interviewed. Employers report they have a total of 701 vacancies at present. It is projected that by 1970 an additional 1, 145 electrical and electronic technicians will be needed bringing the total to 5, 636. The "other" classification of electrical and electronic technicians includes job functions requiring various combinations of abilities from the other classifications. Table 13 presents a detailed breakdown of interview findings.

TABLE 13

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS FOR TECHNICIANS IN THE ELECTRICAL AND ELECTRONIC FIELD

Classifications	Presently Employed[a]	Present Vacancies[a]	Total Projected Employment 1970[a]
1. Electrical Technician	635	41	901
2. Electronic Technician	646 (18)	103 (1)	1, 204 (19)
3. Electro-Mechanical Tech.	825	33	945
4. Electronics Mechanic	182	43	367
5. Control Room Technician	8	1	9
6. Audio Operator	24 (4)	2 (2)	31 (6)
7. Instrumentation Tech.	402	16	519
8. Automatic-Equip. Tech.	669	289	1, 008
9. Unclassified Electrical & Electronic Tech.	377	170	627
TOTAL	3, 768	698	5, 611

a. The figures in parenthesis represents the number found in hospitals for the appropriate occupational titles. The total figures for each occupational title include those in parenthesis.

The information in Table 14 indicates that there is a wide diversity of employment opportunities. The largest number in some classifications are employed in the transportation equipment field, SIC 37. However, manufacturers of electronic componants and equipment, communication firms and electrical power firms employ large numbers of electrical and electronic technicians. Particular attention should be paid to the fact that, for purposes of this report, the automotive industry has been classified under SIC 37, transportation equipment, whereas, in fact, their divisions manufacture a number of products and some divisions are actually listed under a SIC code other than 37. However, the information supplied by central offices without a breakdown by SIC codes for divisions. Where the percentage of total employment for any occupational title by Standard Industrial Classification (SIC) is less than five per cent, the types of firms are grouped and the combined percentage figure reported.

TABLE 14

DISTRIBUTION OF TECHNICIAN EMPLOYMENT BY CLASSIFICATION OF FIRMS

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
1. Electrical Technician	Various (See Appendix A, Part 1)	20, 26, 28, 30, 33, 34, 35, 89	8.72
	Special Trade Contractors	17	12.76
	Electrical Machinery	36	7.75
	Transportation Equipment	37	55.57
	Electric, Gas & Sanitary	49	5.17
	Electrical Goods	50	10.02
2. Electronic Technician	Various (See Appendix A, Part 1)	15, 17, 20, 23, 24, 26, 28, 29, 30, 32, 33, 34, 38, 39, 49, 50, 82	23.86
	Ordnance & Accessories	19	9.27
	Machinery (Except Elec.)	35	16.11
	Electrical Machinery	36	29.33
	Transportation Equipment	37	9.42
	Communication	48	12.01
3. Electro-Mechanical Technician	Various (See Appendix A, Part 1)	19, 20, 25, 26, 27, 28, 30, 33, 34, 35, 38, 50	15.08
	Electrical Machinery	36	8.36
	Transportation Equipment	37	76.56

TABLE 14 (Cont'd)

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
4. Electronic Mechanic	Various (See Appendix A, Part 1)	16, 23, 25, 27, 29, 33, 38, 89	20.22
	Metal Mining	10	6.01
	Food & Kindred Products	20	13.11
	Paper & Allied Products	26	12.57
	Fabricated Metal Prod.	34	9.29
	Machinery (Except Elec.)	35	9.29
	Electrical Machinery	36	18.03
	Transportation Equipment	37	11.48
5. Control Room Technician	General Contractors (Except Buildings)	16	71.43
	Communications	48	21.43
	Miscellaneous Retail Stores	59	7.14
6. Audio Operator	Various (See Appendix A, Part 1)	28, 49	10.00
	Electrical Machinery	36	60.00
	Communications	48	20.00
	Miscellaneous Retail Stores	59	10.00
7. Instrumentation Tech.	Various (See Appendix A, Part 1)	10, 19, 25, 26, 29, 30, 32, 33, 34, 35, 36, 39	17.30
	Food & Kindred Products	20	5.60
	Transportation Equipment	37	47.33
	Instruments & Related	38	6.36
	Electric, Gas & Sanitary	49	23.41
8. Automatic Equipment Technician	Various (See Appendix A, Part 1)	33, 36, 37, 63	2.09
	General Contractors (Except Buildings)	16	41.11
	Communications	48	46.80

Some of the communications firms see a growing need for electronic technicians; but because much of the older equipment is still in use and will be in the near future, they have a continuing need for electrical and electro-mechanical technicians.

Projections for all firms meeting employment criteria have been carefully considered. It was not considered appropriate to make estimates for smaller firms. On the basis of information obtained from firms interviewed, estimates of need are shown in Table 15 for like firms meeting the criteria as to the number of employees. (See Appendix A, Part 1.)

TABLE 15

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE ELECTRICAL AND ELECTRONIC-RELATED FIELD, 1970[a]

Classification	Estimates of Occupational Need		
	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. Electrical Technician	901	294	1,195
2. Electronic Technician	1,204	495	1,699
3. Electro-Mechanical Technician	945	155	1,100
4. Electronics Mechanic	367	86	453
5. Control-Room Technician	9	15	24
6. Audio Operator	31	28	59
7. Instrumentation Tech.	519	80	599
8. Automatic Equipment Technician	1,008	120	1,128
9. Unclassified Electrical & Electronic Technician	627	d	627
TOTAL	5,611	1,273	6,884

a. Data includes only those needs of employers who met criteria for inclusion in the study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers as shown in Table 13.

c. Computed. (See Appendix A, Part 7, for method of computation.)

d. No estimates have been made for the unclassified category of electrical and electronic technicians.

Minimum Educational Requirements

The minimum educational requirements for electrical and electronic technicians vary with the employer's product and technician utilization as well as the number of technicians employed. Firms involved in the less sophisticated areas of electronics generally establish a high school graduation as the minimum educational requirement. These employers sometimes require, in addition, experience or military service training.

Manufacturers of sophisticated electronic components and products, firms which perform complex instrumentation testing, and establishments doing research and development in this field, have established higher standards as their minimum requirements. The actual requirements vary. Some firms require their electrical and electronic technicians to have had one or two years of post-high school education. Some firms require experience; but some of these firms will accept training in the military service in lieu of experience.

Electronic Technology Students
with their instructor
in electronics laboratory
of community college

It is evident that minimum educational requirements are influenced by the supply of electrical and electronic technicians. The lack of such trained technicians has resulted in the lowering of these requirements. Firms which are in a better bargaining position, i.e., those than can offer higher salaries or recruit from a larger area, have maintained higher standards. Some firms, because of the nature of their product, must maintain a high minimum level of educational requirement.

Preferred Educational Requirements for Electrical and Electronic Technicians

The majority of firms, regardless of the level of electrical and electronic technicians they employ, prefers that these technicians have some post-high school technical education. In the large firms, where this is a minimum requirement, it is preferred that technicians have work experience prior to employment. The post-high school training may be obtained at a technical school or a public educational institution. Some military training is also applicable.

Inadequacies in the Education of Electrical and Electronic Technicians

Very few firms have had experience with graduates of a formal post-high school program for electrical and electronic technicians. Employers did, however, suggest what should be included in a post-secondary program for electrical and electronic technicians. Naturally, courses in electricity and electronics would receive emphasis. Mathematics would be necessary to understand these areas. The importance of courses in English and writing are not emphasized for electrical and electronic technicians.

Some understanding of numerical control equipment is essential. One manufacturer had developed an outline on maintenance personnel duties, with related training requirements, for implementation in connection with numerical control equipment. The instructional program emphasizes electrical, hydraulic, and machine repair; but includes also instruction in basic electrical theory related to digital computer circuits (DCC), in addition to training on each numerical control system that the technician would be responsible for servicing. Some technicians, such as electromechanical, will need technical courses in the application of electronics to mechanical processes. Many electrical and electronic technicians deal with clients and general public. They need courses in verbal and written expression as well as psychology. Many employers emphasize the special needs and present inadequacies of personnel required to serve as technical representatives. The technical representatives must have specific background in selling as well as equipment service.

The communications industry would like electrical and electronic technicians who, in addition to their basic courses, have some knowledge of the installation and repair of central office equipment.

Test technicians in automotive manufacturing firms need a background in instrumentation principles and application as well as familiarity with automotive servicing. For those automotive manufacturers that indicated a need for instrumentation technicians, it was found through follow-up interviews that their test technicians needed more than the usual electrical and electronic-mechanical preparation. Training is required in all aspects of automotive mechanical failures and servicing.

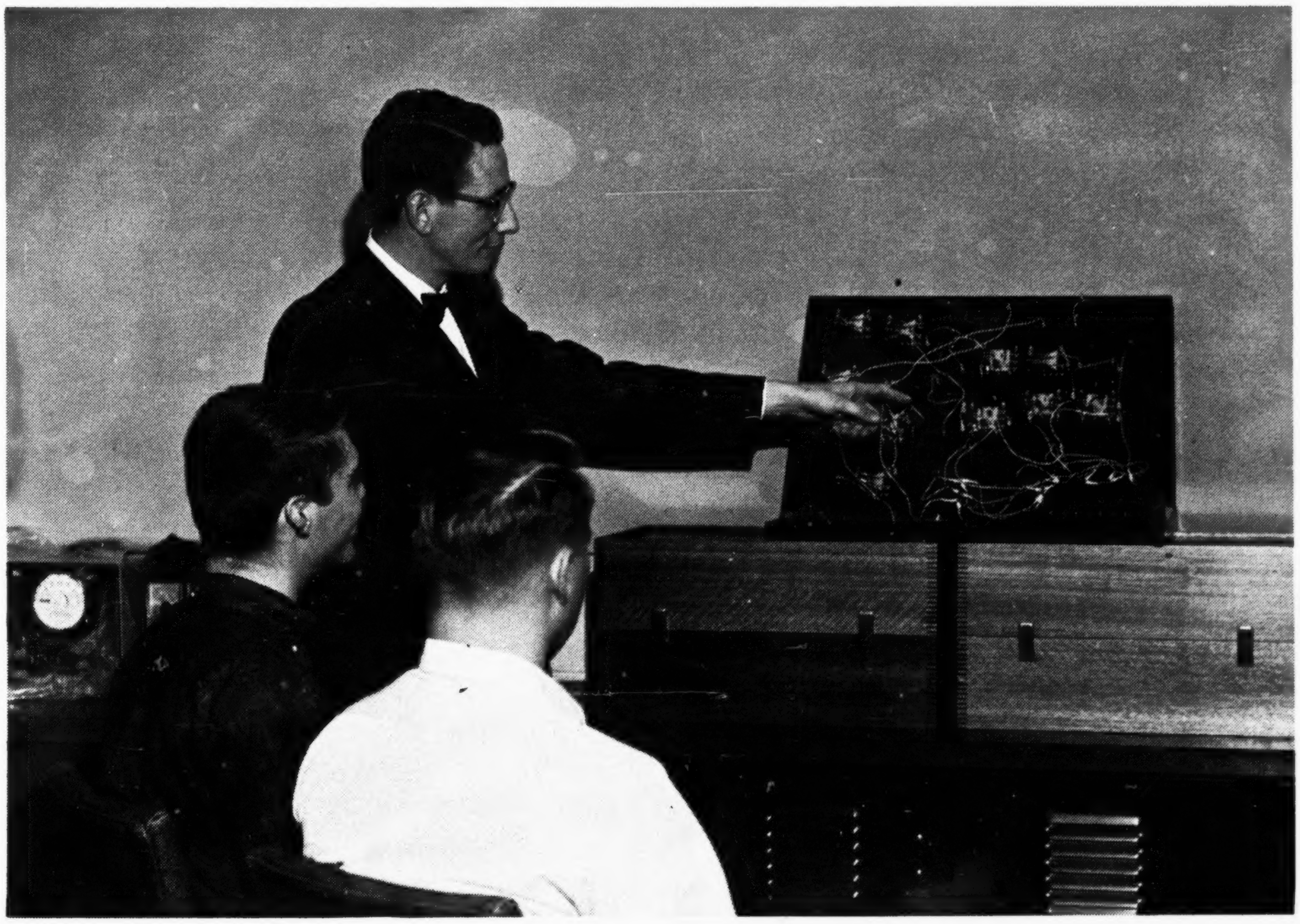
Electrical power firms suggested the following would be necessary for technicians working in their area: Basic electricity, mechanics for generation, drafting, and verbal skills.

Training Opportunities for Electrical and Electronic Technicians

Many employers emphasized that there should be more training opportunities for electrical technicians. They require technicians to have had instruction in electronics but there was still significant emphasis on circuitry and related technology without undue emphasis on electronic theory. They recognize also the difficulty in making such a separation but their needs are for an individual who typically works with resistors, capacitors, inductors, transformers, relays, switches, generators, batteries and motors. In summary, they need electrical technicians who work with conversion of electrical energy to mechanical (as in motors), in changing temperature of the environment (as in heaters), or in routing information over wires (as in telephone switch gear and telegraphy). One interviewee in the communication field indicated that it would be a number of years before they phase out the type of electrical equipment on which instruction in electrical technology would provide the best preparation.

Large firms which need and employ technicians in this field generally provide in-service training programs which are tailored to the firms needs. Informal on-the-job training is provided by many firms, both large and small, employing electrical and electronic technicians.

Training for electrical and electronic technicians is available at public institutions as well as through firms employing these technicians. Community colleges and other post-high school institutions presently offer 24 programs in this area with a total of 1,421 students enrolled as of the fall of 1966. Nine additional programs are planned. There are several private schools offering various programs in these areas. They draw many students who are employed full-time. In many cases, the students attend both private and public institutions on a tuition-refund program sponsored by their employers.



Peg Board Electronic Training Aids
are used by instructor
in electronics program
at state college in Michigan

Many firms which utilize electrical and electronic technicians have accepted the training responsibility. The before-mentioned tuition-refund programs are one example of this involvement. Some large firms have intra-corporation technical institutes where in-depth training is available. One employer has developed an advanced electronics training course in three phases with a total of 376 hours of instruction. The first two phases of the training program involve a review of basic electricity, introduction to electronics, vacuum tube fundamentals, transistor fundamentals, basic vacuum tube and transistor circuits. The third phase of the training course deals with such subjects as wave analysis, special circuits, computer mathematics, computer circuits, synchros and servos, together with industrial applications of decision devices and electronic control. It was noted that their program provided for a breakdown in emphasis between classroom and laboratory instruction with about 40 per cent of the time devoted to laboratory experiments. Internal training programs provide an upgrading opportunity for both trainees and for presently employed technicians.

Some electrical and electronic technicians have worked up through apprentice and other training programs in the skilled trades to their present classifications as a technician. It was noted that the related instruction segment in the industrial apprentice training programs contain courses in physics, electrical theory, and electronic theory. When the related instruction is taken at a college and credit is received, the apprentice meets the defined criteria of this study for a technician, especially upon completion of the apprentice training program. The inclusion of such college level courses makes it difficult to distinguish between graduates of apprenticeship programs and the definition for technician used in this study.

Although it is apparent that training is available from many sources, the preference of employers is for technicians who have in-deph pre-employment training and indicates a need for more programs at post-secondary institutions. Cooperative work experience in electrical and electronic technology is preferred also if it is done as an integral, planned, and scheduled part of the curriculum. Such cooperative education provides opportunities for skill development in addition to the orientation and induction into the world of work.

General Comments

"The electronic area is booming at the present time. The need for technicians in this area has greatly increased."

"One problem of the electronic industry is that not enough mechanical engineers have actual electronic training."

"The electronic area isn't as developed in Michigan as it is in the East. They probably will not be getting in this area in the near future because adequately trained technicians for the electronic industry are not available in Michigan."

FOOTNOTE REFERENCES

[1] New York State - Department of Labor, Division of Research and Statistics, *Technical Manpower in New York State*, Special Bulletin 239, Volume II (December, 1964), pp. 67-80.

[2] *Ibid*, p. 68.

CHAPTER VIII

TECHNICIAN OCCUPATIONS WITHIN THE HEALTH RELATED FIELD

The occupational titles used in the health-related field stimulated many comments from interviewees. The concept of position functions, occupational titles, and necessary minimum qualifications of employees vary considerably among employers. The inclusion of the licensed practical nurse as a technician was considered inappropriate by some of the interviewees. However, it was included in the list of occupational titles on the basis of the definition of a technician used for the study on the basis of a pamphlet issued by the National Association for Practical Nurse Education and Services.[1] The pamphlet sets forth "content necessary for developing the abilities required to meet the nursing needs" and includes anatomy, biology, chemistry, physics, bacteriology and nutrition. It was considered that the emphasis on physical and life science was sufficient for inclusion in the Technician Need Study.

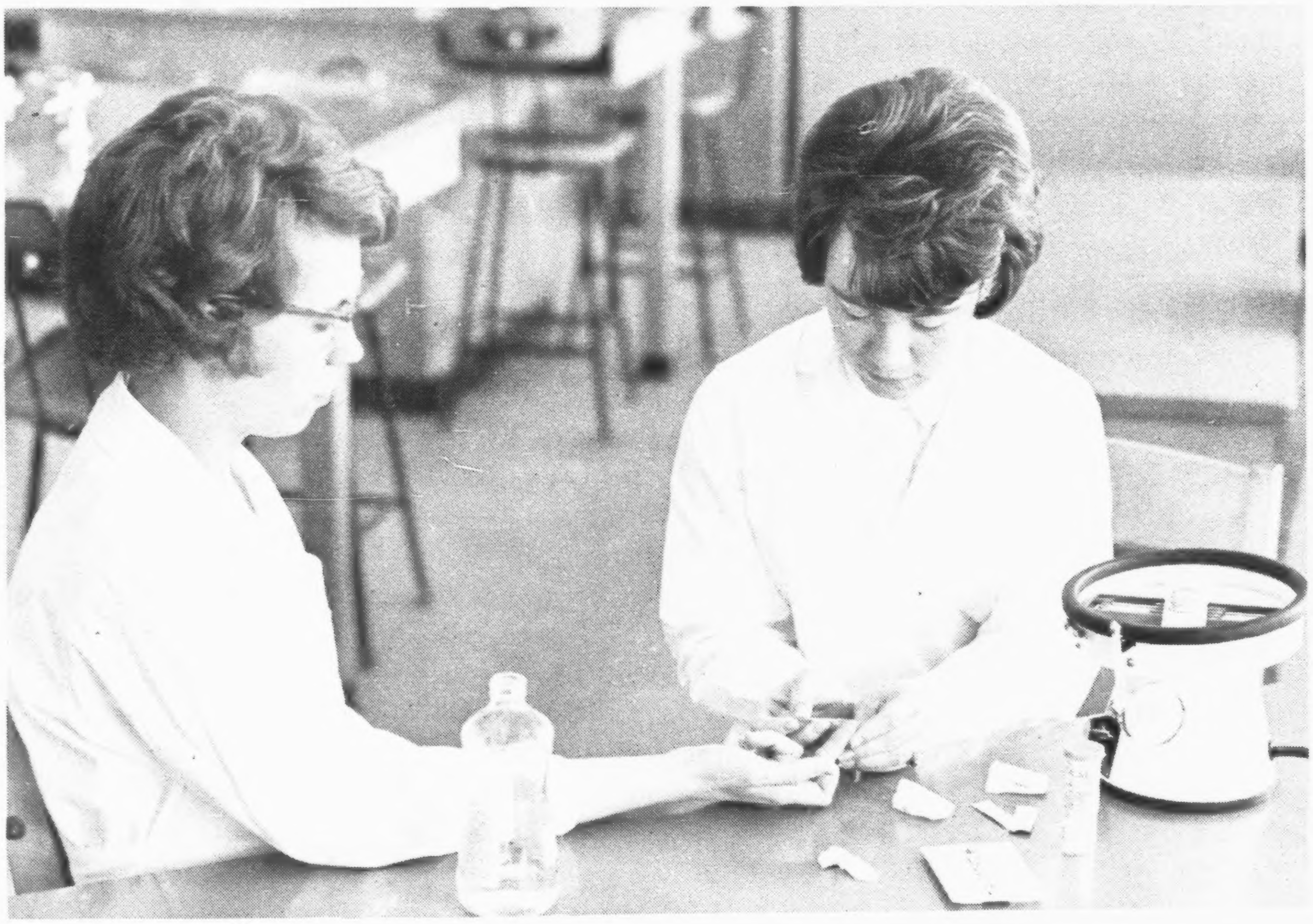
Following the interviews with hospital personnel, it was apparent that one of the classification definitions was insufficient and that three additional classifications of technologists should have been included in the survey. The employment statistics had not been based upon uniform definitions for the titles for which the employers furnished information. These titles, as indicated in Appendix B, Part 1, are Inhalation Therapist, Medical Secretary, Medical Records Technician and Food Service Supervisor (Dietary Aid). The Inhalation Therapist classification had been used from the beginning of interview activity but a more complete definition was required and the definition for Food Service Supervisor (Dietary Aid) had been used for a few interviews on a trial basis.

New, or substantiation of previously obtained data regarding employment in the classifications listed in the preceding paragraph was obtained by mailing a supplemental questionnaire to the participating hospitals. Analysis of the responses to this questionnaire indicated that, because of the functions performed, there was some doubt as to the inclusion of the Food Service Supervisor (Dietary Aid) as a health occupation technician. In some cases, the more complete occupational definition for Inhalation Therapist resulted in a reduction of employment information furnished at the time of the interview. In other cases, present and future needs were expressed that had not been previously indicated.

The occupational title of Food Service Supervisor is included on the basis of such a position being filled by a person with some background in dietetics who can provide assistance to a hospital dietitian. The emphasis on nutrition, and other physical and life science subjects in a limited number of curriculums was considered to be sufficient for inclusion as a health-related technician.[2] The emphasis on health sciences in the training related to Inhalation Therapist and Food Service Supervisor (Dietary Aid) Classifications is also a basis for their inclusion.

In addition to the many comments by employers during the interviews, the use of the supplemental questionnaire elicited many letter responses. The entire medical-clerical field was discussed during interviews and was also the subject of comments in correspondence received. The discussion and comments indicate a lack of uniformity in a concept of position functions and the qualifications of the employee. In this study, the principal occupational titles involved are Medical Assistant, Medical Secretary and Medical Records Technician. In addition, information was obtained on Medical-Clerical personnel that included such titles as Medical Stenographer, Ward Secretary, Ward Clerk, Ward Managers, and Medical-Clerical Technicians. The criteria for inclusion in the Technician Need Study of any Medical-Clerical personnel was based on the emphasis in physical and life science subjects included in some post-secondary curriculums. The analysis of the information on Medical-Clerical is summarized in the next three paragraphs.

The formal training of the Medical Assistant includes many of the same subjects studied by the Medical Secretary; however, few formally trained Medical Assistants are employed in hospitals. This finding is partially the result of the definition used in the study for Medical Assistant. (See Appendix A, Part 3.) The title definition is not comparable to the emphasis in most formal training programs. Most educational programs prepare for the type of position usually associated with a physician's office and referred to as Physician Office Assistant. The Medical Secretary may be employed in the physician's office because, in some instances, some of the duties of a Physician Office Assistant are a part of the training for Medical Secretary.



Students in training for Physicians Office Assistant
practice on one another in Medical Laboratory
Techniques course at a state
college in Michigan

The criteria for inclusion of the Medical Secretary was not unanimously received by all employers interviewed. However, most employers do view a medical Secretary as more than an individual with preparation in stenographic subjects and a year of biology with the addition of a course on medical terminology. Many employers indicated a preference for preparation in the physical and life science subjects in addition to secretarial training. Such programs exist which provide for requirements that include 25 per cent of the total curriculum in science subjects. However, there were none found in Michigan educational institutions.

In addition to meeting the criteria of physical and life science subjects in the post-secondary educational program, the Medical Records Technician is included on the basis of information suppled by the American Association of Medical Records Librarians. In some cases, the employers indicated a description of functions and employee qualifications for other medical-clerical classifications which reflected on-the-job training for reclassification as Medical Records Technician. Therefore, the various classifications not included in the list of definitions used for the survey and on which employers furnished employment information, have been grouped under the heading of Medical-Clerical Technician and employment information included in Tables 16, 17 and 18. The emphasis on health sciences was the principal basis for their inclusion.

In the occupational titles that pertain to clinical laboratory services, the employers interviewed have many different concepts regarding the educational and experience requirements. This arises because of the various registries. However, this study used the registry requirements and related occupational functions set forth by the American Society of Clinical Pathologists (ASCP) but did include medical laboratory technicians for which employers indicated certification as AMT by accrediting bureau of the Association of Medical Technologists. The Medical Laboratory Assistant title listed under health related (Appendix A, Part 3), includes the following additional titles for clinical laboratory technician: Certified Laboratory Assistant CLA (ASCP-ASMT), Cytotechnologist CT(ASCP), Histologic Technician - HT (ASCP), and Medical Technologists - AMT. The functions listed for such titles appear to fit the definition of a technician for inclusion in the study. The employment information is included under item 6 in Table 16. To meet registry requirements of the American Society of Clinical Pathologists (ASCP), the Medical Technologist - MT (ASCP) included under item 17 of Table 16 must now complete a four year educational program -- three years in a college program and one year in an approved hospital training school.

Hospitals and Other Health Institutions Included in the Survey

The survey of the health related field includes AHA (American Hospital Association) approved hospitals, osteopathic hospitals, and private medical and dental laboratories. Technicians within the health field serve as supportive personnel to doctors and other professional medical personnel. Individual offices of physicians and dentists were not among the firms interviewed. Figures for medical assistant, dental assistant and dental hygienist are, therefore, not representative because these technicians are generally employed within such offices.

Officials of 73 hospitals were interviewed. The hospitals include 64 that are listed in the 1965 Guide Issue of Hospitals, Journal of the American Hospital Association, and nine osteopathic hospitals. From the 1965 Guide Issue it was determined that 95 AHA registered hospitals in Michigan met the criteria for inclusion in the study. The 64 that participated represent approximately 63 per cent of total employment in the 262 registered hospitals listed in the Guide Issue. The sample used was based upon geographic location and type of hospital.

The information to determine inclusion of osteopathic hospitals was obtained from the Michigan Osteopathic Hospital Association. Nine of the fourteen requested participated in the study. These represent 61 per cent of the total Michigan employment in Osteopathic hospitals. In addition, 11 private medical laboratories and 26 dental laboratories participated.

During the time in which the interviews were conducted, Medicare went into effect. During the interviews, some of the most important needs emphasized were in the restorative therapy and related categories. These include Occupational Therapy Technicians, Physical Therapy Technicians, and Orthopedic Appliance Technicians, with the greatest need in the Occupational and Physical Therapy fields. Employers indicated a need for four technicians for each registered therapist. It is anticipated by hospital personnel that Medicare will result in a need for more technicians; however, the intensity and the degree of this demand are not known. The projections for 1970, then, reflect somewhat this unknown potential need. But, they are the best estimates of needs that could be given by hsopital personnel at the time of the interviews.

Present Employment, Present Vacancies, and Projected Needs for 1970

Within the hospitals and private laboratories interviewed, there is a total of 14,479 health science technicians presently employed. There were vacancies for 2,794 health-related technicians indicated at the time of the interviews. Without including retirement and transfers, it is anticipated in 1970 that 1,380 more health-related technicians will be needed, bringing the total number of health technicians to 18,654 for the employers interviewed. Table 16 presents a detailed breakdown of interview findings.

TABLE 16

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS FOR TECHNICIANS IN THE HEALTH RELATED FIELD

Classifications	Present Employment	Present Vacancies	Total Projected Employment 1970
1. Nurse, General Duty	6,419	1,486	8,247
2. Nurse, L. P.	4,056	807	5,213
3. Radiologic Technologist	576	54	705
4. Electrocardiograph Tech.	126	13	156
5. Electroencephalograph Tech.	48	9	57
6. Medical-Lab Assistant Includes CLA (ASCP-ASMT) CT-(ASCP), and HT-(ASCP)	629	91	822
7. Nuclear Medical Tech.	18	3	38
8. Medical Assistant	10	2	16
9. Inhalation Therapist	148	27	210
10. Dental Hygienist	4	4	8
11. Dental Assistant	34	—	36
12. Surgical Technician	487	80	663
13. Food Service Supervisor	126	12	203
14. Attendant, Phy. Therapy	92	16	148
15. Dental-Lab. Tech.	388	16	425
16. Optician, Dispensing	8	—	8
17. Medical Tech. :MT-(ASCP)	591	80	844
18. Medical Secretaries	260	40	382
19. Medical Records Tech.	111	41	204
20. Medical-Clerical Tech.	270	24	307
21. Unclassified Health Tech.	78	3	101
TOTAL	14,479	2,794	18,793

It should be noted that the occupational title of General Duty Nurse was used in the Study. The information requested during the interviews related only to registered nurses not in supervisory or administrative positions. The classification of General Duty Nurse was taken from the 1965 edition of the Dictionary of Occupational Titles. Although industrial firms may classify their nurses as Industrial Nurses of Occupational Nurses, for purposes of this Study they are included under General Duty Nurses. In this respect, there was a departure from the practice of emphasis on job functions.

The employment distribution by type of employer was not prepared for the health related occupational titles. The number employed outside the medical and health service field is not significant. Manufacturing firms employed approximately 12.6 percent of the nurses listed under general duty in this study.

Projections were made for employment of technicians in health related occupations in two steps. During many of the interviews in hospitals, the interviewee did not care to make projections of future needs. Therefore, based upon those hospitals interviewed and furnishing projections estimates of 1970 needs have been computed. Table 17 presents the computed estimates. No estimates have been made for the unclassified category of health technicians listed in Table 16.

TABLE 17.

ESTIMATES OF TECHNICIAN NEEDS FOR 1970 COMPUTED FOR HOSPITALS INTERVIEWED BUT NOT MAKING PROJECTIONS COMBINED WITH PROJECTIONS SUPPLIED BY HOSPITALS

Technician Classification	Projections Supplied by Hospitals[a]	Computed Estimates for Hospitals not supplying Projections	Total
1. Nurse, General Duty	8,247	6,846	15,093
2. Nurse, L. P.	5,213	4,473	9,686
3. Radiologic Technician	705	512	1,217
4. Electrocardiograph Tech.	156	139	295
5. Electroencephalograph Tech.	57	107	164
6. Medical-Laboratory Assistant	822	580	1,402
7. Nuclear Medical Technologist	38	15	53
8. Medical Assistant	16	0	16
9. Inhalation Therapist	210	87	297
10. Dental Hygienist	8	18	26
11. Dental Assistant	36	34	70
12. Surgical Technician	663	538	1,201
13. Food Service Supervisor	203	40	243
14. Attendant, Physical Therapy	148	106	254
15. Dental-Laboratory Tech.	425	7	432
16. Optician, Dispensing	8	4	12
17. Med. Tech. :MT(ASCP)	844	(b)	844
18. Medical Secretary	382	50	432
19. Medical Recs. Tech.	204	39	243
20. Medical-Clerical Tech.	307	203	510
21. Unclassified Health Tech.	101		101
TOTAL	18,793	13,798	32,490

a. Employer estimates, see Table 16.

b. Data not available to compute estimates because employers interviewed did not furnish sufficient information for this classification.

Thereafter, estimates of need were computed for all hospitals not surveyed but which meet the interview criteria according to number of employees.

TABLE 18

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE HEALTH RELATED FIELD, 1970[a]

Classification	Estimates of Occupational Need		
	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. General Duty Nurse	15,093	5,433	20,526
2. Nurse L. P.	9,686	3,735	13,421
3. Radiologic Tech.	1,217	434	1,651
4. Electrocardiograph Tech.	295	117	412
5. Electroencephalograph Tech.	164	62	226
6. Medical-Laboratory Assistant	1,402	475	1,877
7. Nuclear Medical Tech.	53	30	83
8. Medical Assistant	16	3	19
9. Inhalation Therapist	297	138	435
10. Dental Hygienist	26	12	38
11. Dental Assistant	70	30	100
12. Surgical Technician	1,201	503	1,704
13. Food Service Supervisor	243	57	300
14. Attendant, Physical Therapy	254	110	364
15. Dental-Laboratory Tech.	432	9	441
16. Optician, Dispensing	12	6	18
17. Medical Tech. :MT-(ASCP)	844	443	1,287
18. Medical Secretary	432	206	638
19. Medical Rec's. Tech.	243	131	374
20. Medical-Clerical Tech.	510	166	676
21. Unclassified Health Tech.	101	d	101
TOTAL	32,591	12,100	44,691

a. Data includes only those needs of employers who met criteria for inclusion in the study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers and computed for interviewed hospitals in Table 17.

c. Computed (See Appendix A, Part 7 for method of computation.)

d. No estimates have been projected for the unclassified category of health technicians.

Minimum and Preferred Educational Requirements

A wide variety of practices are found that relate to minimum and preferred educational requirements, unless these requirements are specified by licensing and registering agencies. With existing personnel needs, and with limited availability of trained personnel for health occupations, many employers maintain some sort of on-the-job training program. The minimum and preferred educational requirements for registered nurses, licensed practical nurses, registered medical laboratory technicians, dental hygienists and radiologic technologists are the same as those required by respective licensing are registering boards. Interviewees stated that the training provided by hospitals for electrocardiograph technicians, electroencephalograph technicians and surgical technicians is satisfactory. Some preference was indicated for substantial work experience or post-secondary formal training by the employers of non-registered medical laboratory technicians.

Most Inhalation Therapists at present are not registered. Formal educational programs will be needed as hospitals begin to require registration. The recognition of more formal training for employment in the Inhalation Therapy area is a recent trend. Those institutions where the need is recognized have followed the recommendations of the Council on Medical Education and Hospitals of the American Medical Association, the American Assoication of Anesthesiologists, the American College of Chest Physicians, and the American Association of Inhalation Therapy. These interested organizations have been instrumental in establishing a means for registry through the American Registry of Inhalation Therapists.

At the present time, very few of the hospitals included in the study utilize the services of physical Therapy Attendants (Technicians). During the interviews, employers emphasized the need for a "technician" that meets the criteria set forth in this study for such designation. The training for such technicians would provide the minimum qualifications for performance for some physical therapy functions. Different views were expressed by hospital administrative personnel and the registered physical therapists. Administrative personnel set forth manpower requirements at the technician level.

The role of a Physical Therapy Aide has only recently been recognized by the professional membership group, the American Physical Therapy Association.[2] The title in the 1965 Dictionary of Occupational Titles is "Attendent, Physical Therapy" and the definition for this title was used. However, irrespective of the title used by other sources, the primary emphasis in this study is on the functions to be performed at a technician level and the requirement of significant pre-employment training in health sciences. Many employers indicated that they usually provide training for practical nurses, nurses aides, and orderlies to perform routine tasks under the supervision of the professional physical therapists.

Inadequacies in Education of Technicians in the Health Related Field

Discussion regarding inadequacies in the education of technicians was particularly void of new ideas or problems, especially during interviews at hospitals. It is difficult to pinpoint the reasons for this lack of interest or information. The educational requirements for adequately trained technicians had not been thoroughly considered by some of the interviewees. In some cases, the individual assigned by the hospital administrator as the interviewee was too far removed from everyday operations. Furthermore, such individuals were not at a level of responsibility that would provide familiarity with the educational deficiencies of the technicians. Some of the interviewees had not had intensive involvement in health technology functions as a part of their preparation for present positions.

In many situations, personnel directors or managers and clerks appear to follow educational requirements set forth by licensing or registration boards or agencies. However, some interviewees had given considerable thought to education deficiencies. Use is still being made of a 1952 publication on job descriptions and qualifications in hospitals.[3] They expressed difficulty in providing related course work on a systematic and scheduled basis for the hospital training programs; concern was also indicated regarding the content of the courses and the period of training.

Improved quality in course content is considered as an advantage of using post-secondary educational institutions for related instruction requirements in hospital directed training programs. The colleges are in a better position to give ample attention to the student's reasoning development, ability to follow instructions, and the acquisition of "tool knowledges." This type of preparation increases the readiness of the individual for the work requirements.

Instructor makes point
with second-year student
in Dental Assisting laboratory
at a Michigan college

Some of the interviewees expressed the need for a basic core of subjects in the physical and biological sciences such as anatomy, zoology, biology, chemistry, and physics, in health occupation educational programs. The use of a core approach would enable a student to acquire more of the "tool knowledges" for their specific vocational education. The greatest areas of deficiency are mathematics and science. More attention to applied mathematics was emphasized for the health occupations field. This, together with appropriate science preparation, is closely related to the necessary technical skills of health science technicians. All of the classifications have weaknesses in these areas.

There has not been sufficient analysis of the health occupations functions and corresponding manpower specifications for existing occupations titles. Specific educational requirements, therefore, cannot be spelled out. The 1952 publication previously mentioned is currently in the process of being revised. The primary findings in the collected data for the revision reveals changes in organizational sturcture in a number of new occupational titles.[4] In a study conducted for the National Commission on Technology, Automation, and economics Progress, it was found that there were more changes in general educational development and specific vocational preparation requirements for the new positions in the "medical services" category than there were in existing positions.[5]

In addition to their remarks on mathematics and science, the interviewees related viewpoints and findings regarding other requirements of specific educational need for health occupations. Deficiencies in English and writing were mentioned almost as frequently as deficiencies in science and mathematics. Health technicians, it was said, have difficulty in writing reports, filling out forms and spelling.

The technicians who are in contact with patients frequently display weakness in human relations. It was suggested that more psychology courses and practical experience might correct this problem and also improve the technician's ability to get along with his associates.

Interviewees indicated that if formal educational programs were planned for medical laboratory technicians, courses should be included to familiarize the technician with automated equipment. However, employers cautioned going overboard on automation. Laboratory technicians will still need to know how to perform tests manually with a corresponding understanding of the scientific principles. The owner of a medical laboratory commented, "Automation will help, but it won't eliminate the need for laboratory personnel. Medical technologists should not be taught on automated machines. It is important that they understand how to run the tests themselves."

There are a few programs available for Medical Secretaries, but the graduates have been disappointing. A medical secretary needs, in addition to secretarial skills, a strong background in the sciences. Medical nomenclature is not a substitute for nor does it provide adequate background for "tool knowledges" in life sciences.

One interviewee recommended that all health technicians be given some courses in Business Administration. Frequently, technicians advance to supervisory positions and must make or contribute to administrative decisions. Even if the technician doesn't reach this level, he will be more receptive to administrative decisions, if he is familiar with the aspects of administration.

Training Opportunities[7]

Educational institutions recognize the need for health-related technicians and have prepared programs accordingly. In 18 public educational institutions, a total of 46 health-related programs are offered. In the fall of 1966, there were 2,473 students enrolled in there programs. Educational institutions plan to expand their programs in the health field. At the time schools were interviewed, they revealed plans for 54 health occupation programs. This includes more programs for Associate Degree Nurses and Practical Nurses as well as programs for such positions as Medical Records Technician, Hospital Engineering Technician, and Public Health Technician.

Environmental Sanitation Student
pursues research project in laboratory session
at a state college in Michigan

Training Opportunities for RN's

There are three educational tracks open to persons interested in being a Registered Nurse. These are baccalaureate degree programs, hospital diploma programs, and associate degree programs. In addition, several hospitals offer refresher courses for nurses who have left the labor market. The Bachelor of Science degree programs are beyond the generally accepted educational level of technicians. It was assumed that graduates of baccalaureate program would quickly advance to supervisory and administrative positions and would not usually be classified as a General Duty Nurse. This group was not closely studied in this survey.

The majority of the present Registered Nurses received their training in a hospital diploma program. Eleven hospitals interviewed presently have such a program. These are, of necessity, the larger hospitals. Nine hospitals are alliliated with college level programs in nursing and provide the clinical training. Those hospitals involved in some form of training for registered nurses are willing to admit that they are involved because they hope to relieve their own shortages and meet future nursing needs. Interviewees often stated that the hospital trains out of necessity and would gladly relinquish this function to the various educational institutions. Hospitals could then concentrate entirely on medical health care.

Associate Degree Nursing programs, because of shorter training period (two years), are graduating nurses at a more rapid rate than the diploma (three years) or baccalaureate (four years) programs. There are ten associate degree nursing programs in the state with a combined enrollment of 984 students. Eight additional programs are planned.

The availability of training opportunities in health occupations requires qualified instructors in sufficient number to meet the needs. Community college representatives indicated that they are unable to accept well qualified student applicants because of the shortage of qualified instructors. The reasons given for the shortage of instructors, primarily, is the inability to find a sufficient number who meet the criteria of the Michigan Board of Nursing and the National League of Nursing. Many of the comments made regarding shortages of qualified instructors cannot be substantiated in guide lines set forth by the Michigan Board of Nursing.[8] The shortage of nurses in Michigan is a result of the lack of training opportunities. In part, the shortage can be met by expanding the associate degree programs to meet the standards as set forth by the Michigan Board of Nursing. Only secondarily should the emphasis by on instructor qualifications for such programs as this may relate to national accreditation requirements.

The acceptance of Associate degree nursing programs has been good, although a two-year program does not provide the clinical experience of the diploma and baccalaureate degree nurses. The opportunities for clinical experience are limited during a two-year academic program. However, interviewees reported that within six months to a maximum of one year, the associate degree nurses are equally as good in the performance of general nursing duties as are nurses trained under the other types of programs. Hospital personnel view the shorter program as being the salvation of hospitals with a critical shortage of general duty nurses.

Training Opportunities for LPN's

Since the inception of the Manpower and Development Training Act (MDTA), many additional programs were established for practical nurses on an institutional basis. These programs accelerated the enrollments in practical nursing programs to meet increased demand. The MDTA programs have been financed with federal funds. However, with some "phasing out" of federal support, institutions where new programs were instituted under MDTA are considering the continuation of such programs. Some educational institutions have had training programs for practical nurses for a number of years. The MDTA focused educational attention on the existing programs and increased enrollments. To meet future demands, a need was stated for continuance of such programs but with consideration also to initiating an associate degree program that would enable a student to qualify for registration. Nine practical nursing programs at community colleges and other public educational institutions have an enrollment of 589 students. Five additional programs are planned. Many of the hospitals included in the survey provide clinical experience for students in these programs.

Training Opportunities for Radiologic Technicians

Many hospitals train their own radiologic technicians. This is usually a combination of formal classroom courses and on-the-job training. Public educational institutions provide some of the related course work training in this area. At present, there are four programs at post-secondary institutions with a combined enrollment of 47 students. Four additional X-ray programs are planned.

Some of the community college representatives indicated not only their interest, but the extent to which they had gone in attempting to plan and adopt a 24-month program. However, they were concerned that the approving councils required a 33-month program. This is difficult for them to understand because the 24-month program in the hospital training school was acceptable. Community college faculty members find it difficult to view the hospital training program as a composite of realistic educational experiences. The question was posed: "How much of the 24 months spent in a hospital training program constitutes educational experience rather than repetitive practice of learned skills?" Interested educational institutions have reviewed the registry requirements in suggested programs of the American Registry of Radiologic Technologists, together with the American College of Radiology and the American Society of Radiologic Technologists. One community college did obtain tentative approval for their 24-month program on the basis of its continuance in the hospital where located, with the college assuming the responsibility for the required ralated course work.

Radiologic Technology students
at a state college in Michigan
receive simulated training
through instructor demonstration
with life size dummy

Training Opportunities for Electrocardiograph Technicians, Electroencephalograph Technicians, Inhalation Therapists, Surgical Technicians, Physical Therapy Attendants, Nuclear Medical Technicians and Medical Records Technician

Many practices exist and will continue to exist that provide for training by the employer, especially in the hospitals. Practices vary between large and small hospitals. For example, it was found in some small hospitals that the Medical Technologists (ASCP) were trained on the electocardiograph and performed the work of the technician in addition to the regular clinical laboratory duties. In other situations, usually large hospitals, the electrocardiograph technician and the electroencephalograph technician may be one individual who has been trained on the job at the hospital for both technical classifications.

Most Inhalation Therapists have had no opportunity for formal instruction. Many of the hospitals interviewed do not realize the need for such a technician. Statements were made "that any orderly or nurse's aide" could perform the functions. In the past five years, the Council on Medical Education and Hospitals of the American Medical Association has cooperated with, the American Society of Anethesiologists, the American College of Chest Physicians, and the American Association of Inhalation Therapists to set forth acceptable standards for hospital training schools to supply qualified inhalation therapy technicians.[9]

One such formal training program has been recently established at a community college. At the present time, it is structured as a one-year program, but plans have been made to incorporate the general education requirements essential to the awarding of an associate degree. Twenty students were enrolled in the program at the time of the visit. The completion of formal education and on-the-job training will lead to eligibility for registration by the American Registry of Inhalation Therapists.

In addition to the registered nurses who have been performing various surgical technician functions, practical nurses have been trained in operating room techniques. Training opportunities for the classification of surgical technicians have been increasing. Most of the programs are located in hospitals. However, a need is recognized for some formal course work at the collegiate level and some of the hospitals plan to require related course work at local colleges.

Recognition has only recently been provided for a formal training program to develop the "Physical Therapy Aide." However, the "Guidelines for Physical Therapy Aide Training" do not meet the technician criteria desired by some employers. Also, many hospitals have and will continue to use the "attendant" and continue also to meet their needs through scheduled on-the-job training, combined with formal course work for related instruction requirements. There were no formal programs for Physical Therapy Attendants (technicians) found in the post-secondary institutions visited.

Nuclear Medical Technologists are very rare. Hospitals are not providing training for this sophisticated specialty.

As previously mentioned, Medicare has brought about the need for new classifications in the health occupations field. One such classification is the Medical Records Technician. Training opportunities have not been available in the past to meet the critical needs. The Medical Records Technician works with the Medical Records Librarian, or without such supervision in small hospitals. At present, community colleges in Michigan do not offer a program for this occupation. However, two educational institutions are planning to initiate such training. The American Association of Medical Records Librarians suggests the following technical areas be included in the one or two year programs for the technicians:

Technical Course Content	Clock Hours
Medical Terminology	30
Anatomy	40
Medical Records Science	
(lecture)	65
(laboratory and practice)	600-700

The Association feels the courses in Medical Records Science should be taught by a Registered Medical Records Librarian and that the educational institution offering such a program should be affiliated with a hospital.

Training opportunities could be increased with more recognition for core courses or curriculums.[10] Many college staff members express the need for such an approach but were waiting to see what action other colleges were taking. Included in the classifications for which such core subjects could be provided are the following health occupation position titles: Physical Therapy Technician, Occupational Therapy Technician, Medical Secretary, Medical Records Technician, and Physician's Office (Medical) Assistant. Some of the courses would also be appropriate in Orthopedic Appliance Technician Curriculum. Principally, such courses would be in the life science group with an interdisciplinary emphasis from the physical science group.

The training opportunities that include both the health technology courses and the general education courses would permit students to set an initial goal at the associate degree level. During the first year the core courses could be taken by students in various programs and during the second year they would specialize through higher level course content beyond the basic life or physical sciences. The requirements for a degree would emphasize adequate occupational readiness plus general education. Prospective students could be attracted to such programs at the collegiate level that would not be attracted into hospital training programs.

Training opportunities involve curriculum development that will provide the student with an orientation into the total health occupation field. In addition, many interviewees commented on the desirability of at least one course during the first year that students could select in a specialty area in which they plan to complete their total curriculum. Such a course would emphasize both the theoretical tools and the hands-on skill development in which they would be principally involved upon a completion of all specialty courses.

Some interviewees indicated that training opportunities could be somewhat improved if it were not for the many licensing, accrediting, or registering agencies or associations. Some of these organizations emphasize that the courses must be especially tailored for a particular health occupation program. This would mean that an anatomy course in an associate degree nursing program is not taken by a student in the medical secretarial program. Many school interviewees report problems in providing opportunities because of the expense involved through imposition of special requirements by interested associations, councils, or agencies. However, they do report favorably on their experience in providing clinical practices in affiliated institutions and agencies.

Public educational institutions are planning to provide programs in some of these and other new specialties. One program in each of the following areas is planned: Surgical Room Aide, Inhalation Therapist, Hospital Engineering Technician, and Occupational Therapy Assistant (technician). Two educational institutions plan a program for Physical Therapy Attendant (technician).

Training Opportunities for Medical Laboratory Technician

There was considerable confusion among the interviewees regarding occupational titles, functions, and registration requirements as these relate to a Medical Laboratory Technician. One author commented upon this in a recent study involving the health service industry.[11]

It was found necessary to refine the occupational titles in the questionnaire form (Appendix A, Part 2) to obtain more specific information. The revisions were used in some hospitals and all medical laboratories. The information was consolidated into three classifications for reporting, as indicated in the introduction to this section of the report. The supplementary definitions are included in the appendix. (Appendix B, Part 2.) They were developed from material on medical laboratory personnel, written by registries and other professional organizations that are under medical auspices.

Difficulty in studying medical-laboratory personnel arises from two sources. First, there are a variety of positions titles denoting varying degrees of educational preparation; and second, either as an effect or cause of the first, there are no clear educational paths to becoming a Medical Laboratory Technician. A Medical Technologist approved by ASCP (American Society of Clinical Pathologists) must have completed a four-year post-high school program including one year of specialized training. A Cytotechnologist approved by ASCP must have completed a three-year post-high school program including one year of specialized training. A Certified Laboratory Assistant must have one year of post-high school training. A Histological Technician must also have completed one year of specialized training. Some Medical Laboratory Technicians have only on-the-job training.

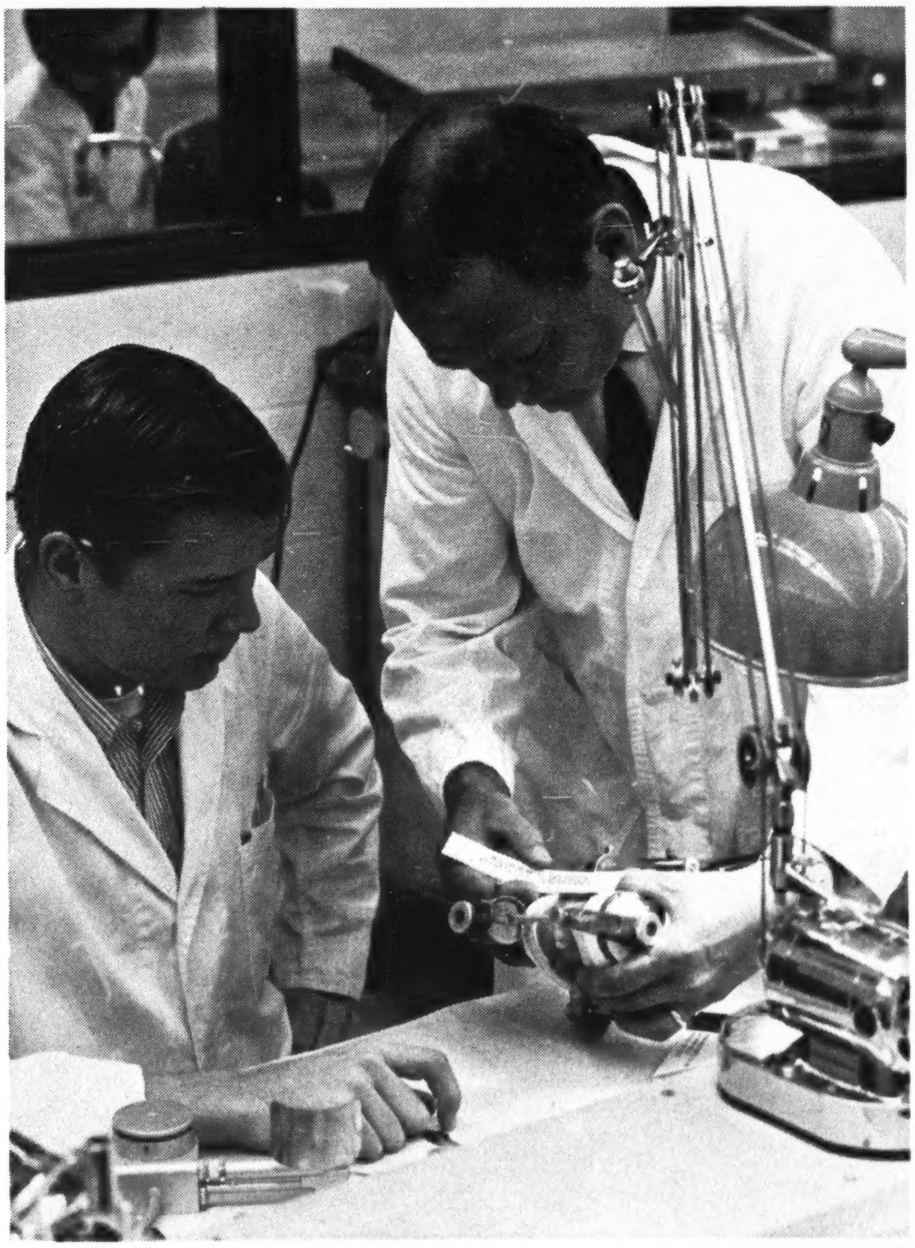
The training opportunities for the technicians other than the Medical Technologist (ASCP) are practically non-existent. One private school has a program for Medical-Laboratory Assistants. One public institution offers a program in this area. The program in the public institution has an enrollment of seventeen students. Four public institutions are planning programs for Medical-Laboratory Technicians.

Hospitals and private laboratories are beginning to install automated equipment. This means more tests can be run in a shorter amount of time. Most interviewees felt there would be no resulting decline in their need for laboratory technicians. The number of tests being requested is increasing and even with automated equipment the human factor is still important. The technician must have the ability to know when results are unreasonable and in emergencies be capable of conducting tests without the assistance of automation.

Educational Opportunities for Dental-Laboratory Technicians

Until recently, formal educational programs in the Midwest for Dental-Laboratory Technicians were available only in private institutions or through Federal (MDTA) training programs. One private institution in Indiana has been a source of job applicants for dental laboratories in

Michigan. Also, employment applications have been received from graduates of a program at a public institution in Illinois. During 1966, one public institution in Wisconsin and one public institution in Michigan have initiated two year programs. Michigan has had one program under the Manpower Development and Training Act at a community college. The program is one year in length. The majority of the present technicians are trained on the job.



Student in Dental Laboratory
Technology program with instructor explaining equipment
at state college in Michigan

Many dental laboratory owners take their educational responsibility seriously. Their trainees learn the phases of work on an accumulative and planned basis. The end result is a productive technician who knows not only the "how" of his work but also the "why." One dental laboratory in Michigan has had a battery of screening tests developed in order to confine investment in training to the best qualified applicants. Some laboratory owners prefer that their employees learn only a few phases and learn these well. For the employee, the work tends to become much like that of an assembly line where there may be no understanding of what comes before or after. Regardless of the laboratory owner's philosophy of training, he is faced with a problem. His primary purpose is to turn out a product and make a profit. He is not in the "education business."

Although the majority of practicing Dental-Laboratory Technicians are not graduates of a formal post-secondary program, dental-laboratory owners do have opinions of how such a program should be organized. They feel a two year program should provide specialized, not generalized training. Generalized core courses should introduce the student to the field, then the program should branch into specialties such as: Full-Denture, Partial Denture, Ceramics, or Crown and Bridge. A dental-laboratory owner made this comment: "Courses should not be generalized. The student should find the area in which they have an aptitude and receive intensive training in that particular field."

Dental-Laboratory owners had other suggestions for educational institutions that are planning programs. "The instructor should be qualified; i.e., he should teach in the area of his specialization, be it dentures, crown and bridge, or ceramics." "Educational institutions teaching a Dental-Laboratory program should have fairly new equipment."

Owners believe the aptitude and capabilities of students should be analyzed before they enter the program. During 1966, an opinion survey on educational standards for Dentral Laboratory Technicians was conducted by the Council of Dental Education of the American Dental Association. The results of this survey could have a significant impact on the development of new criteria and guide lines to provide opportunity for the training of dental laboratory technicians.[12]

A good Dental Laboratory Technician must have 1) imagination, 2) mechanical aptitude, 3) good depth perception, 4) artistic ability, and 5) manual dexterity. The field is open to individuals who possess these abilities regardless of sex or race. Persons with physical handicaps are welcome in the field if the nature of their disability does not interfere with the performance of their job.

Dental-laboratory owners are not convinced that community colleges and other educational institutions are capable of providing the necessary training. Some owners believe a formal apprenticeship would be a better method of training. One owner used the four year apprenticeship program in Australia as an illustration of good training.

At the present time, one public educational institution has a two year program for Dental Laboratory Technicians. There are twenty-four students enrolled. It combines both hands-on experience and theoretical knowledge with emphasis on the former. Four post-high school institutions plan to have programs in this specialty.

The state of training for Dental Laboratory Technicians must be bewildering to individuals wishing to enter the Field. If more programs were available in public institutions, the general public would be more aware of the opportunities. At present, the training lacks form. It takes years for the trainee to "pick up" the skills and knowledge necessary to perform his job. A two year formal educational program or a formal apprenticeship program could give form to this rather chaotic situation by providing planned, progressive steps leading to a degree in proficiency. A program at a community college or other educational institution must encompass a great deal of "hands-on" experience. This is a more efficient and effective method of training Dental Laboratory Technicians than presently exists.

Training Opportunities for Medical Assistant, Dental Hygienist, Dental Assistant, Food Service Supervisor, and Medical Secretary

Training programs for Medical Assistant, Dental Hygienist, Dental Assistant, Food Service Supervisor, and Medical Secretary are available in community colleges and other public educational institutions. There are five programs for Medical Assistants with an enrollment of 174 students. Three new programs are planned.

Dental Hygiene students
receive close supervision from instructors
while working on patients in clinic
at a Michigan college

In the educational institutions surveyed there is a Dental Hygienist program with an enrollment of sixty students. Two other institutions have two year programs in Dental Hygiene, and six institutions are planning new programs. Six educational institutions have programs for Dental Assistants with an enrollment of 251 students. Three more new programs are planned. One institution that has a one year Dental Assisting program is not included. There are three programs for Food Service Supervisors with an enrollment of 92 students, and one new program is planned. There are four programs for Medical Secretary with an enrollment of 182 students. Six new programs are planned.

Continuing Education

Turnover tends to be a major problem in relation to the General Duty Nurse and the Practical Nurse. Many nurses practice their profession for only a few years. After marriage, they often leave the field and return once again when their children are older. Numerous interviewees feel that a refresher course for these nurses would facilitate their re-entry into the labor market.

In questioning the interviewees at the hospitals included in the study, there was only infrequent mention of a tuition refund program. In-service, on-the-job training plus related course work provides the most frequent source for continuing education. Employees in the hospital industry suffer from the lack of "career ladders." The lines between levels become barriers. Recent studies and publications have been emphasizing the problems created.[13] One author emphasizes that the lack of such ladders provides a classic illustration of "blocked mobility."[14]

Administrators and educators readily recognize that registered nurses cannot easily become physicians. However, they do point to opportunities for up-grading within various specialty groups. Examples were cited on the deterrents for a practical nurse that desires to become a registered nurse. The opportunity exists only for the practical nurse who is willing to start at the bottom rung of the ladder without credit for previous training and clinical experience.

It is not sufficient to be critical of hospitals for such policies. Interviewees emphasized that accrediting and licensing organizations and agencies should take a new look at policies and practices. It could mean up-grading to a new classification through pursuance of formal course work in off-duty hours, especially with tuition refund-assistance. Another example is in the medical laboratory where, with a tuition-refund program, interested individuals could complete the formal course work required to move from one certification level to a higher one.

General Comments: Health

"Colleges should provide more technician training programs and thus relieve the hospitals of this duty."

"We are quite in favor of the Associate Degree nursing program. Also, we would like to see a cooperative program developed so that more males will be attracted to the field. On such a program, the student could work by day at the hospital and train through night courses or weekend courses."

"The greatest problem in the technician area is that the turnover is quite extensive."

"Hospitals are performing the training function that should be done by educational facilities. However, because the need is so great for technicians, the hospitals have had no alternative."

"Students completing their Medical Technology program are being employed in manufacturing at much higher salaries."

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CHAPTER IX

TECHNICIAN OCCUPATION WITHIN THE CIVIL RELATED FIELD

The grouping for the Civil-Related field was nebulous. Some of the occupational titles are used by manufacturing firms as well as the civil and construction field. In the New York study of technical manpower,[1] distinction was made between two separate categories, namely: 1) structural design and related specialists, and 2) civil engineering and construction technicians and specialists. Such a distinction was not made for the Technician Need Study in Michigan.

Technical occupations in the civil-related field involve drafting. Therefore, three classifications included in the drafting group for the Michigan Technician Need Study could be listed under the civil-related group. However, in this study, civil, structural, and architectural draftsmen were listed as separate occupational titles under the drafting and design grouping of occupational titles for interview purposes and are likewise included in that chapter in this report. The New York study uses two classifications related to civil technology functions. They are "structural designers" and "designers related to construction (highways and streets)".[2] The structural design technicians have functions similar to the structural draftsman. The civil draftsman functions are similar to those of the designers involved in highways and streets.

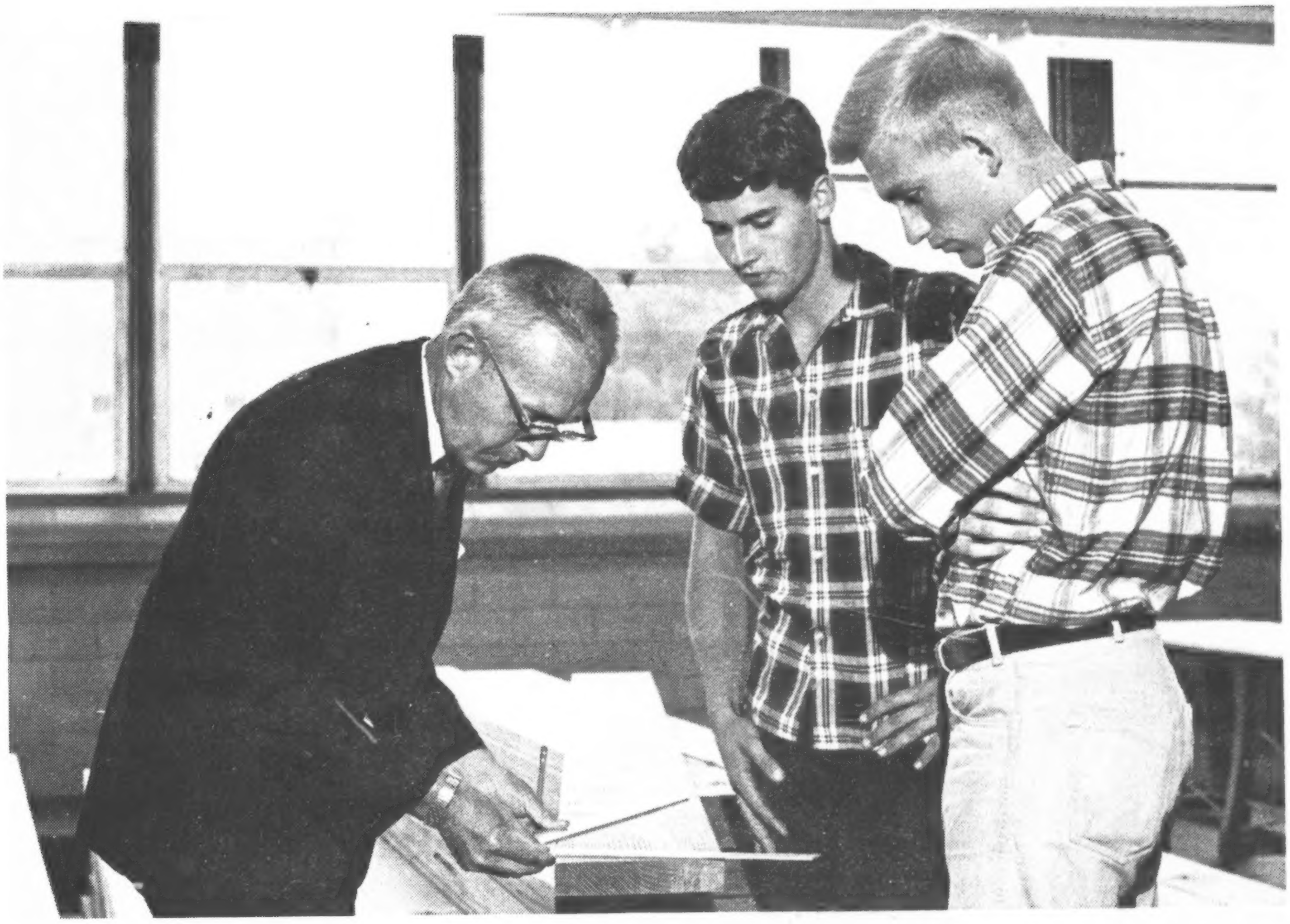
The study procedure involved the use of classification definitions from the Dictionary of Occupational Titles, usually with only one definition selected which could apply to all types of firms. This would mean that some manufacturing firms in heavy machinery may have included a structural design position in their statistics that would be closely related to the duties of a civil-related technician. For example, during the interview activity, no distinction was made between the estimator in manufacturing industries and the estimator in construction industries. In the projections cited in the New York study, a distinction is made between construction cost estimators which are a part of the civil technology group and the estimators in manufacturing which were included under the category of "industrial engineering and related specialists."[3] The introduction of new curriculums in post-secondary institutions in both civil technology and building construction technology, with various occupational options, could change the requirements of employers for technicians in "civil-related fields."

Present Employment, Present Vacancies, and Projected Needs for 1970

In this study civil-related technicians were found to be concentrated in building construction firms, mechanical contracting firms, and asphalt construction firms. Presently, these types of establishments employ very few technicians. The majority of their employees are either craftsmen or laborers. Most of the existing technicians found in contract construction worked their way up through the crafts -- many were formerly carpenters.

The technical occupations in the civil-related area include Surveyors and Estimators. In addition to these classifications,[3] the "other civil technicians" include Field Superintendents, Expeditors, Material Coordinators, Soil Testers, and Materials Testers. The Field Superintendent supervises and coordinates activities of workers engaged in construction and repair; plans work schedules for construction and maintenance projects; interprets and explains plans for construction of new projects. The Expeditor, or Materials Coordinator, insures that merchandise, supplies and equipment are shipped by vendor on promised shipping date; may arrange for distribution of materials upon arrival; may inspect products for quality and quantity to insure adherence to specifications. Soil Testers test and make maps of soil composition of building site; and provide information used in foundation construction. Materials Testers examine composition and quality of materials, such as concrete and asphalt used in construction.

Very few post-secondary educational institutions provide programs for construction technicians. Many interviewees felt educators had been slow in responding to the industry's needs, though they appreciated the difficulties in developing technical programs for an industry with a predominance of craftsmen and tradesmen with apprenticeable entry points to attain journeyman status.



Students observing
instructor in Building
Construction Technology
program at a state college
in Michigan

Presently, there are 1,258 civil-related technicians in the firms interviewed. These firms have 138 technical vacancies now and anticipate they will need an additional 388 technicians by 1970. This would bring the predicted 1970 employment of technicians to 1,784. These projections may be understated because of the present limited use of technicians. If more formally educated civil technicians are available in the future, the demand could be greater than estimated. Table 19 presents a detailed breakdown for civil-related technicians in the firms interviewed.

TABLE 19

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS FOR TECHNICIANS IN THE CIVIL RELATED FIELD

Classification	Presently Employed	Present Vacancies	Total Projected Employment 1970
1. Surveyor	127	14	182
2. Estimator	926	93	1,259
3. Unclassified Civil Technicians	205	31	343
TOTAL	1,258	138	1,784

The figures for estimator include not only estimators in contract construction but also estimators in manufacturing firms. In addition, the estimator classification was found in an adjustment bureau. Their functions as claim adjustors involve some of the knowledge, skills, and abilities required of estimators and it will be noted that they are listed as employed in the type of firm included under SIC code 64. The technicians were found in the types of firms presented in Table 20. Where the percentage of total employment for any occupational title by Standard Industrial Classification (SIC) was less than five per cent, the types of firms are grouped and the combined percentage figure reported.

TABLE 20

DISTRIBUTION OF TECHNICIAN EMPLOYMENT BY CLASSIFICATION OF FIRMS

Occupational Title	Classification of Firms Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Titles By SIC
1. Surveyor	Transportation Equip.	37	3.85
	Metal Mining	10	13,85
	General Contractors Bldgs.	15	6.15
	General Contractors (Except Bldgs.)	16	11.54
	Primary Metal Industries	33	11.54
	Electric, Gas & Sanitary Services	49	13.08
	Miscellaneous Services	89	40.00
2. Estimator	Various (See Appendix A, Part 1)	15, 16, 19, 20, 22, 25, 26, 27, 28, 30, 31, 32, 33, 36, 38, 39, 89	27.25
	Special Trade Contractors	17	7.89
	Fabricated Metal Products	34	9.94
	Machinery, Except Elec.	35	17.11
	Transportation Equip.	37	11.17
	Electric, Gas & Sanitary Services	49	10.25
	Insurance Agents Brokers and Services	64	16.39

Projections for all firms meeting the criteria have been carefully considered. Projections are made only for firms that meet the employment criteria as established for this study. On the basis of information obtained from firms interviewed, estimates of need are shown in Table 21for like firms meeting the criteria as to the number of employees. (See Appendix A, Part 1).

TABLE 21

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE CIVIL-RELATED FIELD, 1970[a]

Classification	Estimates of Occupational Need		
	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. Surveyor	182	141	323
2. Estimator	1,259	873	2,132
3. Unclassified Civil Tech.	343	d	343
TOTAL	1,784	1,014	2,798

a. Data includes only those needs of employers who met criteria for inclusion in the study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers as shown in Table 19.

c. Computed. (See Appendix A, Part 7, for method of computation.)

d. No estimates have been projected for the unclassified category of civil technicians.

Minimum Educational Requirements and Preferred Educational Requirements.

The technical positions in the contract construction industry are not well defined. These positions are usually filled by people who have worked their way up. Many firms have no educational minimum for technicians; however, there is frequently a requirement that the technician have several years of work experience. Firms that have a minimum educational requirement usually require that applicants be high school graduates. Surveyors, estimators, and other civil-related technicians usually have had informal on-the-job training in addition to work experience.

The lack of civil-related programs for technicians seems to have had an effect on preferred educational requirements as well. Interviewees preferred that surveyors have completed a two-year program beyond high school; but this is not usually a preference for technicians in other civil-related areas. It is generally preferred that estimators have several years of work experience. Employers are more concerned that technicians have interest, aptitude, and work experience rather than formal education.

Inadequacies in Education of Civil Related Technicians

Employers in the civil-related industry have had little experience with formally educated technicians. Many interviewees, however, see possibilities of fulfilling their manpower needs in the future through technician educational programs. They suggested that the following courses should be included in a civil-related technology program:

1) Critical Path Method
2) Cost Coding
3) Technical Report Writing
4) Blue-Print Reading
5) Math: College Algebra and Trigonometry
6) Labor Relations
7) Construction Materials
8) Public Speaking
9) Supervision
10) Reading Tables and Graphs

Technical programs for surveyors would, of course, be concerned primarily with surveying courses, though some of the above courses should be included to develop orientation to the specialty in the world of work. Employers also feel that work experience, possibly through a cooperative educational program, would be desirable in any civil-related technology program.

Students in Civil Technology program
at state college in Michigan
use open spaces for their laboratory
in surveying course

Training Opportunities

Civil-related technicians, as previously mentioned, frequently are craftsmen or tradesmen who had attained journeyman status prior to assignment as technicians. They have completed an apprentice program, though not one designed especially for an estimator or surveyor, and have had many years of work experience.

None of the firms interviewed has a formalized training program for technicians. A few firms have tuition-refund programs in which technicians may participate. Through tuition-refund, the technicians can take work related courses at an educational institution and be reimbursed part or all of the tuition. Most firms give their technicians informal on-the-job training, and some of the contract construction associations offer seminars in supervision.

In the educational institutions, the prospects for specialized training are not much better. At present, there are five programs for civil-related technicians in Michigan with a combined enrollment of 162 students. Five additional civil technology programs are being planned.

The contract construction industry representatives stated that they are pleased with the present programs offered at educational institutions and that they would like to see more good programs developed. The conflicts which might arise if potential technicians are graduates of a two-year technology program rather than completing an apprenticeship need to be solved. In some cases, the technology graduate may have to complete an apprentice program after he is employed. If this is necessary, the technology graduate should be given some credit for his post-high school education.

General Comments

"English and writing beyond the high school level are not necessary for work in supervision. Technicians should have the basics of engineering and be able to read graphs and tables. The Assistant Job Superintendent might or might not be in the union. On smaller jobs, the Job Superintendent might have to pick up his tools and go to work. For this reason, union men are preferred on such jobs. On bigger jobs, it is possible that technicians might be used. The most important aspect of their training is labor relations."

"I believe it would be good for a foreman to have a background in a two-year technology program."

"We have found the best prospects for supervisors in the apprenticeship programs. Five years ago we would have felt there was no place for technicians in this industry. There has been a change in thinking. We can utilize graduate engineers better by the use of technicians. However, technicians are limited and we don't want too many of them."

"We do not have time to train technicians ourselves. We have not felt the impact of any technician training yet. One problem with a two-year technical graduate is his difficulty in understanding the difference between salary and hourly pay."

"The construction industry doesn't seem to be getting to the high school students. Few students plan to enter the field upon graduation as an actual career."

FOOTNOTE REFERENCES

[1] New York State Department of Labor, Division of Research and Statistics, Technical Manpower in New York State, Special Bulletin 239, Volume II, (December 1964), pp. 40-44, 46-47.

[2] Ibid., pp. 299-306.

[3] Ibid., pp. 270-276.

3

CHAPTER X

TECHNICIAN OCCUPATIONS WITHIN THE INFORMATION RELATED FIELD

The occupational titles discussed in this section were not a separate group during the collection of information. However, after review of all information obtained during the interviews, it was determined that each definition for the various titles included significant responsibilities in the handling of information. The functions might involve arrangement for computer application and compilation; there may be need for graphic portrayal of information; the information may require reproduction in the form presented; or there may be a need for the systematic flow of information. As a technical writer, the Specification Writer also could have been classified in this section. However, the primary functions of the Specification Writer in manufacturing involve process and material specifications for manufacturing purposes, including a description of the processes involved. Therefore, the primary functions were the determining factor when placing this occupational title in the report section of "Production Technicians."

The growing concern in communication has resulted in the evolution of specialized occupations. Such positions are: Detail Programmer, Clerical Technician, Technical Illustrator, and Reproduction Technician. The Detail Programmer codes information and processes data through a computer. The clerical Technician evaluates procedures of handling information and analyzes and compiles data to insure systematic flow for distribution. Some employers use Industrial Engineering Technicians to handle these functions; in fact, they considered this classification to be the "Industrial Engineering Technician in the Office." During the interviews, this occupational title was frequently found to be associated with the functions of a systems analyst and grouped with the data processing section. Many employers have a baccalaureate degree requirement for personnel assigned as systems analysts. The Technical Illustrator presents information graphically. The Reproduction Technician duplicates information. It was found in the course of the Study that, due to developments in copying machines and other types of reproduction equipment, the functions of a Reproduction Technician do not always require specialized training. However, at the technicial level, there are occupations requiring knowledge of not only duplicating processes, but also knowledge of certain printing techniques.

Although these technicians are found in all types of industries, large firms more commonly employ these specialists than small firms; even large firms generally employ only a small number of these information technicians in comparison to their total employment.

Present Employment, Present Vacancies, and Projected Needs for 1970

Within the firms interviewed, 2,132 Information Technicians are presently employed. There are presently vacancies for 242 Information Technicians and it is anticipated in 1970, 975 more Information Technicians will be needed. In 1970, this would bring the total number to 3,349. Table 22 gives the detailed breakdown.

TABLE 22

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS FOR TECHNICIANS IN THE INFORMATION TECHNICIAN FIELD

Classification	Presently Employed	Present Vacancies	Total Projected Employment 1970
1. Clerical Technician	279	20	375
2. Programmer, Detail Junior	828	115	1,415
3. Reproduction Tech.	293	23	377
4. Technical Illustrator	700	77	1,122
5. Unclassified Information Technicians	32	7	60
TOTAL	2,132	242	3,349

Regardless of size or nature of product, all firms are concerned with communication, both internal and external. Computers of varying levels of sophistication are used in many of the firms interviewed. This necessitates personnel trained in data processing though not all firms utilize the classification of Detail Programmer. Many firms not presently employing Detail Programmers anticipate a future need in this area. Usually, only fairly large firms can afford specialists in the Information field. In other firms, personnel above and below the technician level, may perform some of the specialized job functions.

The information presented in Table 23 indicates that the range of employment opportunities is limited. Attention is directed to various types of firms (SIC code) employing Clerical Technicians; yet, they employed less than twenty-seven (27%) per cent of the total number of that occupational title. The total percentage employed in a particular type of firm by occupational titles is significant. Where the percentage of total employment for any occupational title by Standard Industrial Classification (SIC) is less than five per cent, the types of firms have been grouped and their combined percentage figure reported.

TABLE 23

DISTRIBUTION OF TECHNICIAN EMPLOYMENT BY CLASSIFICATION OF FIRMS

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Title by SIC
1. Clerical Technician	Various (See Appendix A, Part 1)	15, 17, 20, 25, 27, 30, 31, 32, 33, 34, 35, 36, 37, 59, 60, 63, 64	26.47
	Chemical & Allied Prod.	28	73.53
2. Programmer, Detail, Junior	Various, (See Appendix A, Part 1)	10, 15, 17, 19, 20, 22, 24, 25, 26, 29, 30, 31, 34, 36, 39, 42, 48, 49, 50, 53, 54, 56, 59, 60, 61, 63, 73, 89	34.04
	Chemical & Allied Prod.	28	10.06
	Primary Metal Industries	33	7.60
	Machinery (Except Elec.)	35	11.81
	Transportation Equipment	37	36.49

TABLE 23 (Cont'd)

Occupational Title	Classification of Firm(s) Employing Occupational Title	SIC Code(s)	Percent of Total Employment for Occupational Title by SIC
3. Reproduction Technician	Various (See Appendix A, Part 1)	19, 20, 24, 27, 30, 33, 34, 39, 49, 59, 63, 73	27.63
	Chemical & Allied Prod.	28	5.84
	Machinery(Except. Elec.)	35	15.95
	Electrical Machinery	36	6.23
	Transportation Equipment	37	37.35
	Miscellaneous Services	89	7.00
4. Technical Illustrator	Various (See Appendix A, Part 1)	19, 25, 28, 30, 34, 35, 36, 38, 39, 56, 63	16.00
	Transportation Equipment	37	63.00
	Miscellaneous Services	89	21.00

Estimates of needs have been made following the criteria used in other sections of this report. The reliability of the estimates may be such that they are not significant for planning purposes. Three of the classifications provoked many comments from employers. Clerical Technician, Junior Programmer, and Reproduction Technician are not always considered to be occupations requiring post-secondary education and training. In other instances, some employers require four years of post-secondary preparation for programmers and systems analysts. However, on the basis of information obtained from firms interviewed, estimates of need are shown in Table 24 for like firms meeting the criteria as to number of employees. (See Appendix A, Part 1.)

TABLE 24

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE INFORMATION-RELATED FIELD, 1970[a]

Classification	Estimates of Occupational Need		
	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. Clerical Technician	375	220	595
2. Programmer, Detail, Junior	1,415	802	2,217
3. Reproduction Tech.	377	134	511
4. Technical Illustrator	1,122	82	1,204
5. Unclassified Information Technicians	60	d	60
TOTALS	3,349	1,238	4,587

a. Data includes only those needs of employers who met criteria for inclusion in the study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers as shown in Table 22.

c. Computed. (See Appendix A, Part 7, for method of computation.)

d. No estimates have been projected for the unclassified category of Information Technicians.

Minimum Educational Requirements

In most firms the minimum Educational requirement for Clerical Technician, Reproduction Technician, and Technical Illustrator is high school graduation. After employment, these employees receive either formal or informal training. Through training and experience, they eventually reach the level of a technician. Junior Detail Programmers must have some form of training at the post-secondary level. This may be prior to or after employment. Many Detail Programmers receive training from computer manufacturers if they are employed by a firm which has a computer.

Preferred Educational Requirements

Most employers interviewed prefer that these technicians have some form of post-high school education prior to employment. In addition, they would like the Detail Programmer to have one to two years of experience. Opinions varied on the length and depth of post-secondary programs desired. Some employers indicated that, irrespective of the length of a program in a post-secondary education institution, most new employees would start by performing functions at a very elementary level in the data processing section.

Inadequacies in the Education of Information Technicians

Few employers have had contact with Information Technicians who have graduated from a post-secondary program. The exception is Detail Programmers. The comments indicate that Detail Programmers need a strong background in math. This would include courses in statistics, algebra, and calculus. A program for Detail Programmers should also include courses in report writing, industrial coding, business administration, and grammar.

During the interviews, some large manufacturers were directing attention to training their own data processing personnel. Availability of better equipment induced firms to provide the essential training. One firm had just completed a pilot program to train programmers and other personnel. The results were very satisfactory because the fundamentals had been related to the equipment used by the particular employer.

Some employers of Reproduction Technicians emphasized the need for skills in the use of varitype, multilith, multigraph, and various photocopying or other types of copiers. Some of these technicians are involved in putting blueprints on microfilm. No particular inadequacies were noted in the education of Clerical Technicians and Technical Illustrators. This could be because these technicians are not utilized in large numbers. Also due to the limited number of formally trained technicians, few employers are willing to advance opinions about these two classifications.

Training Opportunities

There are presently ten programs in post-secondary educational institutions for Information Technicians. As of the fall of 1966, 403 students were enrolled in these programs. Twelve new programs are planned for the future.

Other training is offered by employers to meet their needs. There is formal and informal on-the-job training. In addition, Detail Programmers may receive training from computer manufacturers. Many firms have tuition-refund programs through which these technicians may be reimbursed all or part of the expense of taking work related courses at public and private institutions.

CHAPTER XI

TECHNICIAN OCCUPATIONS WITHIN THE PRODUCTION RELATED FIELD

Production technician are concerned with the manufacturing processes and with manpower as it affects the processes and product. Their responsibilities and job functions require some technical knowledge. Included in the group are: Industrial Engineering Technicians, Quality Control Technicians, Specification Writers, and Production Supervisors. The Industrial Engineering Technician studies performance of production processes to establish standards and improve efficiency. The Quality Control Technician inspects and tests the product at various stages of the production process. The specification Writer prepares a description of the work methods and processes to be followed and the materials to be used. The required knowledge of particular techniques and skills will vary with the type of industry in which he is employed; but his job functions per se will not. (The Dictionary of Occupational Titles describes the job functions in manufacturing under Process-Description Writer). The Production Supervisor supervises and coordinates activities of workers engaged in one or more occupations who perform the production processes. The classification of Production Supervisor was not included in the list of occupational titles on which information was collected during early phases of the study. However, many comments were made by employers concerning the need for trained supervisors. They indicated that the programs at the post-secondary level were needed and that a cooperative program between industries and schools would be particularly beneficial. Some firms supplied figures of presently employed Production Supervisors and anticipated needs for this classification. These statistics are included in "Unclassified Production Technicians."

Statements in the Employment Impact of Technological Change[1] indicate technical training will become increasingly important for supervisory personnel. The author states, "I feel sure that many highly automatic systems, such as automated warehouses, will require college-trained supervisors. The foremen's job is being upgraded more severely than the worker's job, for it is the foreman who must grasp and respond to a different set of needs, since he is the 'operator' of the master machine--the highly automatic production line."

Present Employment, Present Vacancies, and Projected Needs for 1970

The firms interviewed presently employ 2,845 production technicians and have 286 unfilled vacancies. They anticipate that by 1970 they will need an additional 547, bringing the total employment in 1970 to 3,678 Production Technicians. Attrition has not been included in the projection figures. Table 25 gives the detailed breakdown of Production Technicians.

TABLE 25

EMPLOYMENT STATISTICS FURNISHED BY EMPLOYERS FOR TECHNICIANS IN THE PRODUCTION-RELATED FIELD

Classification	Presently Employed	Present Vacancies	Total Projected Employment 1970
1. Industrial Engineering Technician	802	149	1,255
2. Quality-Control Tech.	1,399	87	1,621
3. Specification Writer	549	25	661
4. Unclassified Production Technicians	95	25	141
TOTAL	2,845	286	3,678

The information presented in Table 26 indicates a diversity of employment opportunities, especially for the Industrial Engineering Technician. Significant percentages are found for two titles in transportation equipment firms, SIC code 37. This classification was used for the automotive industry because all information was furnished by a central office without specific breakdown by SIC code for divisions. The divisions actually manufacture a variety of products and some are listed under a SIC code other than 37. Where the percentage of total employment for any occupational title by Standard Industrial Classification is less than five per cent, the types of firms are grouped and the combined percentage figure reported.

TABLE 26

DISTRIBUTION OF TECHNICIAN EMPLOYMENT BY CLASSIFICATION OF FIRMS

Occupational Title	Classification of Firm(s) Employing Occupational Titles	SIC Code(s)	Percent of Total Employment for Occupational Titles by SIC
1. Specification Writer	Various (See Appendix A, Part 1)	19, 20, 25, 26, 30, 33, 34, 36	27.34
	Machinery (Except Elec.)	35	38.13
	Miscellaneous Services	89	34.53
2. Quality-Control Technician	Various (See Appendix A, Part 1)	14, 19, 22, 23, 24, 25, 26, 27, 30, 32, 39, 59, 73, 89	12.13
	Food & Kindred Prod.	20	8.28
	Chem. & Allied Prod.	28	6.14
	Primary Metal Prod.	33	6.50
	Fabricated Metal Prod.	34	7.14
	Machinery (Except Elec.)	35	6.00
	Electrical Machinery	36	6.35
	Transportation Equip.	37	47.47
3. Industrial Engineering Technician	Various (See Appendix A, Part 1)	10, 20, 22, 23, 24, 26, 28, 30, 31, 32, 38, 39, 89	15.21
	Furniture & Fixtures	25	5.32
	Primary Metal Indus.	33	11.28
	Fabricated Metal Prod.	34	12.29
	Machinery (Except Elec.)	35	20.28
	Electrical Machinery	36	7.86
	Transportation Equip.	37	27.76

Projections are made following the methodology used for technician classifications presented in other sections of this report. The estimates for production technician are not considered totally reliable for planning purposes because of the information on which they are based. Significant data was obtained on Specification Writers from engineering and architectural firms, SIC code 89, because of the definition used in the Study. However, as explained in another section of this report, the definition used was not closely related to manufacturing processes.

According to many employers, there is a current shortage of Industrial Engineering Technicians. Yet, many other employers do not see current shortage or increasing need because of the decreased emphasis on the type of duties performed. The principal point on decreasing needs is related to the decline in incentive or piece work as a basis for computing earnings; some employers indicated that such practices will not be as important in the future as they had been in the past, particularly with automated machinery.

On the basis of the information obtained from firms interviewed, estimates of need are shown in Table 27 for like firms meeting the criteria as to number of employees. (See Appendix A, Part 1.)

TABLE 27

ESTIMATES OF TECHNICIAN EMPLOYMENT NEEDS BY OCCUPATIONAL TITLES IN THE PRODUCTION TECHNICIAN FIELD, 1970[a]

Classification	Estimates of Occupational Need		
	Employers Interviewed[b]	Employers not Interviewed[c]	Total
1. Industrial Engineering Technician	1,255	192	1,447
2. Quality-Control Technician	1,621	918	2,539
3. Specification Writer	661	35	696
4. Unclassified Production Tech.	141	d	141
TOTAL	3,678	1,145	4,823

a. Data includes only those needs of employers who met criteria for inclusion in the study. (See Appendix A, Part 1 for criteria.)

b. Data furnished by employers as shown in Table 25.

c. Computed. (See Appendix A, Part 7, for method of computation.)

d. No estimates have been projected for the unclassified category of Production Technicians.

Minimum Educational Requirements

In general, most firms had only limited experience with employees who had formal post-secondary education and training for the Production Technician classifications. In fact, many employers had not required formal education beyond high school. Therefore, very little consideration had been given to job functions and the qualification requirements that involved post-secondary education.

The Industrial Engineering Technician was the most frequently mentioned technical production classification requiring some post-secondary training. In general, employers are not familiar with the formal programs in community and other colleges. Quality-Control Technicians and Specification Writers usually must have some experience in addition to a high school graduation. Some employers emphasized the need for training in sampling technique such as would be available in beginning and advanced statistics courses. Frequently, training is obtained either formally or informally after employment. Large corporations usually have the same minimum educational requirements but in addition, formal industry classes are mandatory. Some of these large corporations may require a Quality-Control Technician to have some post-secondary training prior to employment.

Preferred Educational Requirements

It was of significance that many employers feel that industrial engineering technician curriculums, with minor revisions, would meet their need for Production Supervisors. They prefer that employees have some experience in production prior to an assignment on industrial engineering functions. If a new employee has specialized post-secondary education in industrial engineering, he still needs a more realistic induction into the world of work and production experience can provide some of the ingredients. Even though some background in statistics is desirable the quality control technician employed by most firms had advanced from work on some phase of production. These technicians, in the past, were not required to have a formal education background in elementary statistics or functional quality control.

The firms interviewed generally agreed that they would prefer Industrial Engineering Technicians to have both post-secondary training and work experience. It is preferrable also that Quality-Control Technicians, Specification Writers, and Production Supervisors have some post-secondary training, and in the case of Production Supervisors, some work experience is desirable.

Inadequacies in the Education of Production Technicians

With the exception of Industrial Engineering Technicians, the majority of Production Technicians presently employed do not have post-secondary training. For this reason, interviewees did not comment on training inadequacies. They would however, like to see more post-secondary programs in the production area developed by educational institutions. Programs for Quality-Control Technicians, according to employers, should include courses in: functional quality control, machine shop, statistics, technical writing, and industrial relations. Industrial Engineering Technicians need courses in industrial relations and technical report writing as well as courses in their specialty of time-study. The desirability of formal programs to train Production Supervisors was mentioned frequently. The following areas should be included in such a program: 1) job principles (supply and demand), 2) job organization, 3) plant supervision (line or staff), 4) production control, 5) supervision and responsibility, 6) union rules, 7) mathematics through trigonometry, 8) technical report writing, 9) electrical theory, and 10) machine shop.

Training Opportunities

There were four programs for Production Technicians in the fall of 1966 with a combined enrollment of 138 students. Six additional programs are planned in the future. Besides these, three private schools offer programs in the production area, but enrollment figures for these programs are not available.

Most production technicians are trained informally on-the-job or through formal industry classes. Large firms frequently provide tuition-refund programs, in which the trainees are reimbursed part or all of the expense of courses taken at an educational institution.

Actual job experience is a very important part of the training of Production Technicians. For this reason, educational institutions should consider cooperative programs when planning production technology.

General Comments

"We can't find men with foremenship training."

"In northern Michigan there is a need for supervisors. These men need not be four-year college graduates. We would prefer older men with experience."

"Present supervisory personnel are inadequately trained. There is a need for technicians in industrial production technology."

"We need women in production supervision."

"Production supervisors lack training, particularly in industrial and human relations. Educational institutions could give this type of training."

"Time-study men are the most difficult technicians to find."

"A two year course for Industrial Engineering Technicians is something that is really needed by industry. These people are in very short supply."

FOOTNOTE REFERENCES

[1] John R. Bright, "The Relationship of Increasing Automation and Skill Requirements," Technology and the American Economy, Appendix Volume II, The Employment Impact of Technological Change, (Washington: Government Printing Office, 1966), p. II-217.

APPENDIX

Appendix A: Basic Items - Technician Need Study

Appendix B: Supplementary Items - Technician Need Study

Appendix C: Training Opportunities in Post-Secondary Institutions

Appendix A

Basic Items - Technician Need Study

Part 1 - Criteria for Selection of Firms

Part 2 - Participation Letter to Personnel Director, Participation Letter to President, Information Sheet

Part 3 - a. Questionnaire (Interview Form)
  b. Condensed Definitions from Dictionary of Occupational Titles
  c. Supplementary Questionnaire on Educational Inadequacies

Part 4 - Confirmation Letter

Part 5 - Follow-up Letter

Part 6 - Number and Employment of Firms Interviewed by Standard Industrial Classification

Part 7 - Method of Computing Estimates for Firms Not Interviewed But Meeting the Criteria

Part 8 - Firms Participating Through Correspondence and Telephone Contacts

STATE OF MICHIGAN

FERRIS STATE COLLEGE

Big Rapids, Michigan 49307

SUBJECT: TECHNICIAN NEED RESEARCH STUDY--Standard Industrial Classification (SIC) and Criteria for Selection of Firms to be Surveyed.

SIC	NATURE OF OPERATION	CRITERIA BY NO. OF EMPLOYEES FOR INCLUSION IN THE STUDY
MINING		
10	Metal Mining	100 or more
13	Crude Petroleum	100 or more
14	Nonmetallic Minerals except fuels	100 or more
CONTRACT CONSTRUCTION		
15	General Contractor's Buildings	75 or more
16	General Contractor's Except Buildings	75 or more
17	Special Trade Contractors'	75 or more
171	Plumbing, Heating, Air Conditioning	50 or more
MANUFACTURING		
19	Ordnance and Accessories	250 or more
20	Food and Kindred Products	250 or more
22	Textile Mill Products	250 or more
23	Apparel and Related Products	250 or more
24	Lumber and Wood Products	250 or more
25	Furniture and Fixtures	250 or more
26	Paper and Allied Products	250 or more
27	Printing and Publishing	250 or more
28	Chemicals and Allied Products	250 or more
29	Petroleum and Coal Products	250 or more
30	Rubber and Plastics Products, NEC*	250 or more
31	Leather and Leather Products	250 or more
32	Stone, Clay and Glass Products	250 or more
33	Primary Metal Industries	250 or more

*Not Elsewhere Classified

SIC	NATURE OF OPERATION	CRITERIA BY NO. OF EMPLOYEES FOR INCLUSION IN THE STUDY
34	Fabricated Metal Products	250 or more
35	Machinery, Except Electrical	250 or more
36	Electrical Machinery	250 or more
366	Communication Equipment	all companies
3679	Electronic Components NEC*	all companies
3699	Electrical Products NEC*	all companies
37	Transportation Equipment	250 or more
38	Instruments and Related Products	250 or more
39	Miscellaneous Manufacturing	250 or more
TRANSPORTATION AND OTHER PUBLIC UTILITIES		
41	Local Passenger Transportation	250 or more
42	Trucking Warehousing	250 or more
44	Water Transportation	250 or more
45	Transportation by Air	250 or more
46	Pipe line Transportation	250 or more
47	Transportation Services	250 or more
48	Communication	250 or more
483	Radio Broadcasting and Television	100 or more
49	Electric, Gas and Sanitary Service	250 or more
WHOLESALE TRADE		
501	Motor Vehicles and Automotive Equipment	250 or more
502	Drugs, Chemicals, and Allied Products	250 or more
503	Dry Goods and Apparel	250 or more
504	Groceries and Related Products	250 or more
505	Farm Products - Raw Materials	250 or more
506	Electrical Goods	250 or more
507	Hardware, Plumbing, Heating Equipment	250 or more
508	Machinery, Equipment and Supplies	250 or more
509	Miscellaneous Wholesalers	250 or more
RETAIL TRADE		
52	Buildings Materials and Farm Equipment	250 or more
53	General Merchandise	250 or more
54	Food	250 or more
55	Automotive Dealters and Service Stations	250 or more

*Not Elsewhere Classified

SIC	NATURE OF OPERATION	CRITERIA BY NO. OF EMPLOYEES FOR INCLUSION IN THE STUDY
551	New and Used Car Dealers	100 or more
56	Apparel and Accessories	250 or more
57	Furniture and Home Furnishings	250 or more
58	Eating and Drinking Places	250 or more
59	Miscellaneous Retail Stores	250 or more

FINANCE, INSURANCE, AND REAL ESTATE

60	Banking	250 or more
61	Credit Agencies Other Than Banks	250 or more
62	Security and Commodity Brokers and Services	250 or more
63	Insurance Carriers	250 or more
64	Insurance Agents' Brokers and Service	250 or more
65	Real Estate	250 or more
66	Combined Real Estate, Insurance, Etc.	250 or more
67	Holding & Other Investment Companies	250 or more

SERVICES

70	Hotels and Other Lodging Places	250 or more
72	Personal Services	250 or more
73	Miscellaneous Business Services	250 or more
7391	Research and Testing Laboratories	8 or more
75	Automobile Repair Service	250 or more
76	Miscellaneous Repair Service	250 or more
78	Motion Pictures	250 or more
79	Amusement and Recreation Services, NEC*	250 or more
80	Medical and Other Health Service	250 or more
807	Medical and Dental Laboratories	8 or more
81	Legal Services	250 or more
82	Educational Services	250 or more
86	Non-Profit Membership Organizations	250 or more
89	Miscellaneous Services	250 or more
891	Engineering and Architectural Services	50 or more

*Not Elsewhere Classified

Example of participation letter sent to Personnel Director

Your cooperation is desired for the success of a research project that has been initiated by Ferris State College. The attached information sheet provides the background information on the Technician Need Research Program.

We desire an expression of interest on your participation. We would need interview time from you or your assistant. The interviews normally take from one and one-half to three hours, depending upon the advance preparation of the company. The enclosed interview questionnaire form provides you with the opportunity to prepare prior to the scheduled interview with a member of our Research Staff. All arrangements to obtain the information are made in advance through this office and reconfirmed by the research staff member assigned to conduct the interview.

Your participation in the Technician Need Research Program should benefit industry in the state through the availability of more technically trained personnel. These technicians will have had more preparatory training through a post-high school, pre-service educational program. The company's on-the-job training programs would not require as much emphasis on basics. In addition, the results from the research project can assist Michigan educational institutions with more meaningful curriculum planning.

We shall be extremely grateful for your cooperation in this project. The information given during the interview will be treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures (3)

Example of participation letter sent to President

Your cooperation is desired for the success of a research project that has been initiated by Ferris State College. The attached information sheet provides the background information on the Technician Need Research Study.

We desire an expression of interest on your participation. Interview time is desired from you or your representative of the Industrial Relations (Personnel) Department. The interviews normally take from one and one-half to three hours, depending upon the advance preparation of the company. The enclosed interview questionnaire form provides you with the opportunity to prepare prior to the scheduled interview with a member of our Research Staff. Arrangements to obtain the information are made in advance through this office and reconfirmed by the research staff member assigned to conduct the interview.

Your participation in the Technician Need Research Study should benefit industry in the state through the availability of more technically trained personnel. These technicians will have had more preparatory training through a post-high school, pre-service educational program. The company's on-the-job training programs would not require as much emphasis on basics. In addition, the results from the research project can assist Michigan educational institutions with more meaningful curriculum planning.

We shall be extremely grateful for your cooperation in this project. The information given during the interview will be treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures (2)

STATE OF MICHIGAN

FERRIS STATE COLLEGE

Big Rapids, Michigan 49307

Department of Administrative Studies, Office Telephone No. 796-8510
Area Code 616.

Subject: Information Sheet on Technician Need Research Study

1. Michigan Agencies Sponsoring the Project:
   a. Michigan Department of Commerce, Office of Economic Expansion.
   b. Michigan Department of Education, Division of Vocational Education.

2. Purposes of Project:
   a. Basis for estimating needs, if any, for new or expanded technician training programs in Michigan.
   b. Help assure industry and hospitals of an adequate supply of appropriately trained manpower.

3. Firms Selected to Participate:
   a. Approximately 70 hospitals in Michigan meeting a criteria of 250 or more employees.
   b. Approximately 1,000 firms in Michigan meeting predetermined criteria according to the Standard Industrial Classification Manual.

4. Method of Obtaining Information:
   a. Upon receipt of letter from firm indicating they will participate in the survey, the project office at Ferris State College sets up a tentative interview time well in advance of the scheduled date. The interviews are conducted at the office of the firm. Opportunity is provided for advance questioning of the interviewer at the time the appointment is confirmed.
   b. Interview by research staff member with representative of your firm.
   c. Questionnaire (attached) which is sent for your review and to provide opportunity for firm representative to plan his role during the interview.

d. Comparison of positions in the firm with the classification definitions for occupational titles from the 1965 edition of the *Dictionary of Occupational Titles*.

5. *The Staff*:
The research staff are full time employees. They are not currently graduate students working on advanced degrees. The present staff members who will be contacting business and industrial representatives for the project are:
a. *Project Director* - James D. (Jim) Kelly who holds B. B. A. and M. B. A. degrees from the University of Michigan and has taken additional graduate study at George Washington University, Washington, D. C.
b. *Research Associates**
    (1) Barton W. (Barth) La Belle
    (2) James E. (Jim) Cherry
    (3) Vicki S. Waffle

---

*Additional information is furnished when tentative interview appointment is made.

FERRIS STATE COLLEGE

BIG RAPIDS, MICHIGAN 49307

Interview Form

Interview Number ____

TECHNICIAN NEED STUDY

Date of Interview:________________By:____________________________
(Research Associate)

1. Firm Name:____

____

2. Firm Address: (If multi-unit, give address of plant interviewed)

____

____

____

3. Standard Industrial Classification:____________________

4. Interviewee Name: Title: Phone:

____

____

____

____

____

5. Total Number of Employees:____________________________

6. For the purpose of this study, a technician is defined as an employee whose job requires basic scientific and mathematical knowledge, or other specialized education or training in some aspect of technology, science, or industry, and who, as a rule, works directly with scientists, engineers, or other professional personnel.

In general, technicians are more intensively trained in fundamentals than craftsmen. In addition, technicians usually become qualified through formal technical training, on-the-job training or a combination of both.

II. TECHNICIAN REQUIREMENTS

Technician Classification	DOT Code	Presently Employed	Would Employ if Available	Estimate of January 1970 Needs
A. Chemical Related				
1. Analytical Research Tech. (Plastics)	008.380			
2. Laboratory Assistant (Metallurgical)	011.281			
3. Chemical-Laboratory Technician	022.281			
4. Laboratory Technician (Petrol. Refining)	029.281			
5. Other				
B. Mechanical Related				
1. Optical Technician	007.081			
2. Mechanical-Engineering Technician	007.181			
3. Mechanical Maintenance Man	620.281			
4. Pneumatic Tester and Mechanic	621.381			
5. Air-Conditioning Mechanic (Domestic)	637.281			
6. Air-Conditioning Mechanic (Commercial)	637.281			
7. Maintenance Technician	638.281			
8. Other				
C. Drafting & Design Related				
1. Draftsman, Architectural	001.281			
2. Draftsman, Aeronautical	002.281			
3. Draftsman, Electronic	003.281			
4. Draftsman, Electrical	003.281			
5. Draftsman, Structural	005.281			
6. Draftsman, Civil	005.281			
7. Draftsman, Product	007.181			
a. Die Designer	007.181			
b. Lay-Out Draftsman	007.281			
c. Industrial Designer	142.081			
d. Tool Designer	007.081			
8. Draftsman, Mechanical	007.281			

II. TECHNICIAN REQUIREMENTS

Technician Classification	DOT Code	Presently Employed	Would Employ if Available	Estimates of January 1970 Needs
C. Drafting & Design Related (Continued)				
9. Draftsman, Mine	010.281			
10. Draftsman, Marine	014.281			
11. Draftsman, Oil & Gas	017.281			
12. Draftsman, Air Cond., Plumbing & Heating	017.281			
13. Draftsman, Map	017.281			
14. Technical Illustrator	017.281			
15. Specification Writer	019.288			
16. Other				
D. Electrical and Electronic Related				
1. Electrical Technician	003.181			
2. Electronic Technician	003.181			
3. Electro-Mechanical Tech.	710.281			
4. Electronics Mechanic	828.281			
5. Control-Room Technician	957.282			
6. Audio Operator	957.282			
7. Other				
E. Civil Related				
1. Surveyor	018.188			
2. Other				
F. Miscellaneous				
1. Instrumentation Tech.	003.281			
2. Industrial Engineering Tech.	012.288			
3. Agricultural-Engineering Technician	013.181			
4. Test Reactor Operator (Nuclear Science Aid)	015.380			
5. Quality-Control Tech.	019.281			
6. Wood Technician	040.081			
7. Dairy Technician	040.081			
8. Clerical Technician	161.268			
9. Programmer, Detail, Junior	219.388			

II. TECHNICIAN REQUIREMENTS

Technician Classification	DOT Code	Presently Employed	Would Employ if Available	Estimate of January 1970 Need
F. Miscellaneous (continued)				
10. Glass Technician	772.281			
11. Automatic-Equipment Tech.	822.281			
12. Reproduction Technician	976.381			
13. Estimator	160.288			
14. Other				
G. Health Related				
1. Nurse, General Duty	017.378			
2. Nurse. L.P.	079.378			
3. Radiologic Technologist	078.368			
4. Electrocardiograph Tech.	078.368			
5. Electroencephalograph Tech.	078.368			
6. Medical-Laboratory Assist.	078.381			
7. Nuclear Medical Technologist	078.381			
8. Medical Assistant	079.368			
9. Inhalation Therapist	079.368			
10. Dental Hygienist	078.368			
11. Dental Assistant	079.378			
12. Surgical Technician	079.378			
13. Food Service Supervisor (Dietary Aid)	319.138			
14. Attendant, Physical Therapy	355.878			
15. Dental-Laboratory Tech.	712.381			
16. Optician, Dispensing	713.251			
17. Other				

III.

1. What are your minimum and preferred educational requirements for beginning technicians?

Technician Classification	DOT Code	High School	Post High Sch. Technical Sch.	College	Military Service School	Formal Industry Class	Informal On-The-Job	Number of Years Work Experience	Age	Other
MINIMUM										
PREFERRED										

2. In what areas, if any, are available technicians inadequately trained?

Technical Classification	DOT Code	English	Writing	Math	Science	Industrial Relations	Tech Skill	Other

3. Does this organization have training programs? ______________________

Technicial Classification	DOT Code	Type of Training Program	Length of Training Program

*4. From where do you recruit most of your technicians?

a. __________Selection, Training and development of existing employees

b. __________Technical Institutes

c. __________Community Colleges

d. __________High schools, but selected employees are required to further their education under tuition-refund program.

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*5. To what extent do existing educational facilities (post-high school) in Michigan meet needs for technicians?

a. As to number required in various occupational classifications?

_____Very Well _____Adequately _____Inadequately

b. As to the adequacy (quality) of pre-service training?

_____Very Well _____Adequately _____Inadequately

6. In what age range would you estimate most of the technicians employed by this organization to be?

(1)____________________ Under 20 years

(2)____________________ 20 - 30

(3)____________________ 30 - 40

(4)____________________ 40 - 50

(5)____________________ Over 50 years

7. What other comments do you have regarding the availability, future supply, or training of technicians?

*Indicates correction, revision, or addition

CLASSIFICATION DEFINITIONS

1965 DICTIONARY OF OCCUPATIONAL TITLES

A. CHEMICAL RELATED	Occupational Code
1. Analytical Research Technician, Resins and Adhesives; Special Adhesive Tech.; Technical Plastics Specialist	007.081
Sets up and operates laboratory-test apparatus to conduct physical and chemical tests of resins and adhesives to determine qualities, such as clarity, content of specific chemicals, or adhesiveness.	
*2. Laboratory Assistant, Metallurgical (Iron & Steel) Metallurgical Analyst; Metallurgical Inspector	007.181
Analyzes data obtained from investigation of physical and chemical properties of metals, or processes used in recovering metals from their ores to select method, standards, and procedures of examination and test reports, or by personal observation and investigation, determines conformance to establish procedures, methods, and standards.	
3. Chemical-Laboratory Technician	620.281
Conducts chemical and physical laboratory tests and makes qualitative and quantitative analysis of materials for purposes such as development of new products, materials, and processing methods, and for maintenance of health and safety standards, working under direction of Biochemist; Chemical-Lab. Chief; Chemist, Analytical; Chemist, Inorganic; Chemist, Organic; or Chemist, Physical.	
4. Laboratory Technician (Petroleum Refining) Tester; Crude Tester; Gas Analyst; Lab. Inspector; Lab. Tester; Oil Tester	621.381
Tests and analyzes sample of crude oil and petroleum products during processing states, using lab. apparatus,	

*Indicates correction, revision, or addition.

Occupational Code

testing equipment, and following standard test procedures to determine physical and chemical properties and insure that products meet quality control standards.

B. MECHANICAL RELATED

*1. Optical Technician 007.081

Designs mechanical portion of precision optical instruments such as aerial cameras, spectrophotometers, and refractometers. Reviews optical specifications to determine types of mounts, test lenses, tools, and fixtures required, and sequence of operations necessary for construction of optical system.

*2. Mechanical-Engineering Technician 007.181
Engineering Tech.; Experimental Tech.; Lab. Development Tech.; Mechanical Tech.

Applies theory and principles to mechanical engineering to develop and test machinery and equipment under direction of engineering staff and physical scientists. Reviews project instructions and blueprints to determine test specifications, procedures, objectives, test equipment, and problems involved and possible solutions. Sets up and conducts tests and experiments of complete units and components to investigate engineering theories regarding improvement in design or performance of equipment to subject equipment to simulated operating conditions. Analyzes indicated and calculated test results against design or rates specifications and objectives of test. Records test procedures, results, and suggestions for improvement.

*3. Mechanical Maintenance Man 620.281
Automobile Maintenance Mechanic; Master Mechanic; Service Engineer; Shop Mechanic

Inspects, repairs, and maintains functional parts of automotive and mechanical equipment and machinery,

*Indicates correction, revision, or addition.

Occupational Code

such as pumps, compressors, pipe-laying machines, ditchdiggers, trucks, and tractors. Inspects defective equipment and diagnoses malfunctions, using motor analyzers, pressure gages, chassis charts, and factory manuals.

*4. Pneumatic Tester and Mechanic — 621.381
Assembler; Test Tech. -Valves; Overhaul Mechanic, Pneumatic Valves; Tester, Pneumatic

Tests, adjusts, and repairs pneumatic units, such as valves, pumps, and regulators, according to specifications, using handtools, power tools, and test equipment. Rejects malfunctioning units and records possible causes of unit malfunction on data sheet.

5. Air-Conditioning Mechanic, Domestic — 637.281
Air-Conditioning Window-Box Serviceman

Services and repairs domestic air-conditioning units, usually ranging from one-half ton to two tons capacity, in private residences and small business establishments.

*6. Air-Conditioning Mechanic, Commercial — 637.281

Installs, services, and repairs commercial air-conditioning units, usually rated in excess of 100 tons cooling capacity.

*7. Maintenance Technician — 638.281

Investigates causes of mechanical failures of operating and maintenance equipment, machinery, tools, and parts and recommends corrective measures. Studies shop and purchase records to determine frequency of failure occurances. Determines corrective measures and writes reports of findings and recommendations.

*Indicates correction, revision, or addition.

C. DRAFTING AND DESIGN RELATED

Occupational Code

DRAFTSMAN I. Prepares clear, complete, and accurate working plans and detail drawings from rough or detailed sketches or notes for engineering or manufacturing purposes, according to specified dimensions.

*1. Draftsman, Architectural 001,281

Performs duties of Draftsman I by planning artistic architectural and structural features of any class of buildings and like structures. Estimates quantities needed for project and computes costs.

2. Draftsman, Aeronautical 002.281

As in Draftsman I, specializing in drafting engineering drawings of developmental or production airplanes and missiles and ancillary equipment, including launch mechanisms and scale models of prototype aircraft, as planned by the Aeronautical Engineer.

*3. Draftsman, Electronic 003.281

Drafts wiring diagrams, schematics, and layout drawings used in manufacture, assembly, installation, and repair of electronic equipment such as T. V. cameras, radio transmitters and receivers, audioamplifiers, computers, and radiation detectors, performing duties as described under Draftsman I. Drafts layout and detail drawings of racks, panels, and enclosures. May conduct service and interference studies and prepare maps and charts related to radio and T. V. surveys.

4. Draftsman, Electrical 003.281

Performs duties of Draftsman I by preparing electrical equipment, working drawings and wiring diagrams used by construction crews and repairmen who erect, install, and repair electrical equipment and wiring in powerplants, industrial establishments, commercial or domestic buildings, or electrical distribution systems.

*Indicates correction, revision, or addition.

Occupational Code

5. Draftsman, Structural — 005.281

Performs duties of Draftsman I by drawing plans for structures employing structural steel, such as bridge trusses, plate girders, roof trusses, trestle bridges and columns, and other integral parts. Makes drawings for masonry or timber members.

6. Draftsman, Civil — 005.281
Draftsman, Civil Engineering; Draftsman, Construction; Draftsman, Engineering

Drafts detailed construction drawings, topographical profiles, and related maps and specification sheets used in planning and construction of highways, river and harbor improvements, flood control, drainage, and other civil engineering projects, performing duties as described under Draftsman I.

*7. Draftsman, Product — 007.181
Product Designer; Engineering Assistant, Mech. Equipment

Designs form of products to be manufactured and associated packaging and trademarks: Sketches design of products, taking into consideration appearance for sales appeal, service-ability in adapting design to function, price, costs and methods of production. Frequently confers with sales and market analysis personnel to obtain design ideas. Coordinates drafting of sketches into working drawings and specification sheets for product, using airbrush. May form models in plastic or clay.

a. Die Designer — 007.181
Design Leader; Die-Design Draftsman; Die-Developing Man

Develops plans for dies for stamping, forging, or extrusion presses, according to blueprints of product and knowledge of press characteristics and process limitations.

*Indicates correction, revision, or addition.

Occupational Code

b. Lay-Out Draftsman — 007.281
Lay-Out Checker

Draws rough sketches and layout drawings of machine design proposals according to engineering data and verifies drafting or detailed working drawings: Sketches layout of machine according to design proposal and standard engineering specifications. Assigns drafting of detail drawings to other personnel and verifies accuracy and completeness of drawings in various stages of completion.

c. Industrial Designer — 142.081

Develops detailed design drawings and related specifications of mechanical equipment according to engineering sketches and design proposal specifications: Analyzes engineering sketches, specifications, and related data and drawings to determine design factors; Drafts detailed multiview drawings of machine and subassemblies; complies and analyzes test data to determine effect of design on machine; modifies machine design to correct operating deficiencies or to reduce production problems.

d. Tool Designer — 007.081
Production Equipment Draftsman; Tool and Equipment Design Specialist; Development Mechanic; General and Special Tools Investigator and Planner

Designs broaches, milling-machine cutter, drills, and other single-or multiple edged cutting tools, and related jigs, dies, and fixtures for production of experimental use in metal working machines; Studies specifications and confers with engineering and shop personnel to resolve design problems. Draws preliminary sketches and prepares layout and detail drawings; modifies tool designs according to trial or production service data to improve tool life or performance.

Occupational Code

8. Draftsman, Mechanical 007.281
Draftsman, Engineering

Performs duties of Draftsman I specializing in drafting detailed working drawings of machinery and mechanical devices, indicating dimensions and tolerances, fasteners and joining requirements, and other engineering data. Drafts multiple-view assembly and subassembly drawings as required for manufacture and repair of mechanisms.

9. Draftsman, Mine 010.281

As in Draftsman I, but specializes in making drawings of mine machinery or structural features of mines from general design drawings or notes made by Mining Engineer. Makes graphic drawings of survey notes made by Surveyor.

*10. Draftsman, Marine 014.281

Performs duties of Draftsman I, but specializes in making drawings of structural and mechanical features of docks, ships and other marine structures and equipment. Works from general design drawings and notes made by architect.

11. Draftsman, Oil & Gas 017.281

Drafts plans and drawings for layout, construction, and operation of oil fields, refineries, and pipeline systems from field notes, rough or detailed sketches, and specifications.

12. Draftsman, Air-Conditioning, Heating and Plumbing 017.281

Performs duties of Draftsman I, but specializes in drawing plans for installation of heating, air-conditioning, and ventilating equipment. May calculate heat loss and heat gain for buildings for use in determing equipment specifications, using slide rule and following standardized procedures.

Performs duties of Draftsman I, but specializes in drawings or plans for installation of plumbing equipment.

*Indicates correction, revision, or addition.

		Occupational Code
13.	Draftsman, Map Cartographer; Map Maker; Mapper	017.281

Draws maps of cities, countries, states, and other areas showing location and identity of roads, communities, commercial or industrial structures and installations, political boundaries, and other features, performing duties as described under Draftsman I.

Occupational Code

D. ELECTRICAL AND ELECTRONIC RELATED

1. Electrical Technician 003.181
Electrical-Laboratory Technician

Applies electrical theory and related subjects to tests and modify developmental or operational electrical machinery and electrical control equipment and circuitry in industrial or commercial plants and laboratories.

*2. Electronic Technician 003.181

Applies electronic theory, principles of electronic circuits, electrical testing procedures, engineering mathematics, physics, and related subjects to layout, build, test, troubleshoot, repair, and modify developmental and production electronic equipment, such as computers, missile-control instrumentation, and machine-tool numerical controls.

3. Electro-Mechanical Technician 710.281

Fabricates, tests, analyzes, and adjusts precision electro-mechanical instruments, such as temperature probes and aerodynamic probes, following blueprints and sketches, using handtools, metal-working machines, and measuring and testing instruments.

4. Electronics Mechanic 828.281
Communication Tech.; Electronics-Equipment Mechanic; Electronics-Maintenance Man; Electronics Specialist; Electronics-System Mechanic; Electronics Technician

Repairs electronic equipment such as computers, industrial controls, radar systems, telemetering and missile control systems, transmitters, antennas, and servomechanisms, following blueprints and manufacturers' specifications, and using handtools and test instruments.

*5. Control-Room Technician 957.282

Controls and maintains control-room equipment in T.V. broadcasting studios. Observes meters, indicators, and cathode ray oscillographs and adjusts controls to maintain technical quality of broadcast.

*Indicates correction, revision, or addition

Occupational Code

6. Audio Operator 957.282
Audio Engineer; Audio Technician; Sound Engineer; Studio Engineer; Audio Control

Controls audio equipment to regulate volume level and quality of sound during T. V. broadcasts, according to script and instructions of Director, Technical (radio and T. V. broadcasts).

7. Instrumentation Technician 003.281

Devises, sets up, and operates electronic instrumentation and relate electro-mechanical or electro-hydraulic apparatus involved in operational and environmental testing of mechanical, structural, or electrical equipment, and translates test data for subsequent use by engineering personnel in making engineering design and evaluation decisions.

8. Automatic Equipment Technician 822.281
Technician, Automatic; Telegraph-Equipment Maintainer; Telegraph-Printer Maintenance Man; Teletype Maintenance Man; Teletype Man; Teletype Repairman; TeleTypewriter Repairman

Analyzes defects in and repairs manual and automatic telegraphic transmitting and receiving apparatus, such as tele-typewriters, facsimile-recording devices and switching equipment.

E. CIVIL RELATED

Occupational Code

*1. Surveyor
Chief of Party; Party Chief 018.188

Surveys earth's surface and oversees engineering survey party engages in determining exact location and measurements of points elevations, lines, areas, and contours of earth's surface to secure data used for construction, map making, land valuation, mining or other purposes. Calculates information needed to conduct survey from notes, maps, deeds or other records.

*2. Estimator 160.288
Cost Estimator

Prepares cost and work completion estimates for engineering contract bids. Compiles itemized materials and price lists from blueprints and specifications. Itemizes equipment to be produced by company or to be purchased from outside sources. Computes cost estimates of raw materials, purchased equipment or subcontracted work and labor.

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*Indicates correction, revision, or addition.

F. INFORMATION RELATED

Occupational Code

*1. Clerical Technician 161.268
Methods Man

Studies clerical and statistical methods in commercial or industrial establishments to develop improved and standardized procedures. May write training manuals and conduct training conferences in new procedures. May write job descriptions and specifications.

2. Programmer, Detail 219.388
Junior Programmer; Program Coder

Selects symbols from coding system peculiar to make or model of digital computer and applies them to successive steps of completed program for conversion to machine processable instructions.

3. Reproduction Technician 976.381
Tracing Cloth Reproduction Technician;
Vacuum Frame Operator

Duplicates, by photographic process, printed material such as photographic positives and negatives, tracings, and documents on sensitized paper, cloth, or film.

4. Technical Illustrator 017.281
Engineering Illustrator; Production Illustrator

Lays out and draws illustrations for reproduction in reference works, brochures, and technical manuals dealing with assembly, installation, operation, maintenance, and repair of machines, tools, and equipment.

*Indicates correction, revision, or addition.

G. PRODUCTION RELATED	Occupational Code
1. Industrial Engineering Technician	012.288

Studies and records time, motion, methods, and speed involved in performance of maintenance, production, clerical, and other worker operations to establish standard production rate and to improve efficiency.

2. Quality-Control Technician	019.281

Tests and inspects products at various stages of production process and compiles and evaluates statistical data to determine and maintain quality and reliability of products.

*3. Specification Writer	019.288

Prepares construction and material specifications to interpret engineers and architects plans for building. Examines plans and diagrams prepared by engineers or architects to determine acceptable materials and construction standards. Writes construction specifications detailing standards of construction.

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*Indicates correction, revision, or addition.

H. MISCELLANEOUS

Occupational Code

1. Agricultural Engineering Technician 013.181

Applies biological and engineering knowledge and methods, and technical skills, in support of agricultural engineering activities, such as design of farm machinery; design and construction of irrigation, power, and electrification systems; soil and water conservation; and processing of agricultural products.

2. Test Reactor Operator 015.380
Nuclear Reactor Technician; Reactor Technician

Sets up and controls operation of nuclear reactor in which neutrons and gamma rays are used to study structure of atoms, determine properties of materials, and create radioisotopes and radio-active fission products for research purposes.

*3. Wood Technician 040.081
Forest-Products Technologist; Wood Anantomist

Conducts research in seasoning, preservation, and utilization of wood and its by-products. Determines methods for curing lumber such as drying in kilns, electrical drying, and exposure to air.

4. Dairy Technician 040.081
Dairy Manufacturing Technologist; Dairy Products Technologist

Applies principles of bacteriology, chemistry, physics, engineering, and economics to develop new and improved methods in production, preservation, and utilization of milk, cheese, ice cream, and other dairy products.

5. Glass Technician 772.281
Glass Blower; Lab Apparatus; Glass Technologist

Develops specifications for, and blows and shapes glass laboratory apparatus, such as test tubes, retorts, and flasks, and glass components for such apparatus as condensers, vacuum pumps, barometers, and thermometers.

*Indicates correction, revision, or addition.

I. HEALTH RELATED

Occupational Code

1. Nurse, General Duty 017.378
Nurse, Staff

Renders general nursing care to patients in hospital, infirmary, sanitarium, or similar institutions.

2. Nurse, Licensed Practical 079.378

Cares for ill, injured, convalescent, and handicapped persons in hospitals, clinics, private homes, sanitariums, and similar institutions.

3. Radiologic Technologist 078.368
X-Ray Technologist

Applies roentgen rays and radioactive substances to patients for diagnostic and therapeutic purposes.

4. Electrocardiograph Technician 078.368
E.K.G. Technician

Records electromotive variations in action of heart muscle using electrocardiograph machine, to provide data for diagnosis of heart ailments.

5. Electroencephalograph Technician 078.368
E.E.G. Technician

Measures impulse frequencies and differences in electrical potential between various portions of the brain, using equipment that records data as a series of irregular lines on a continuous graph to be used by medical practitioner in diagnosing brain disorders.

6. Medical-Laboratory Assistant 078.381
Medical Technician

Performs routine tests in medical laboratories for use in treatment and diagnosis of disease.

Occupational Code

*7. Nuclear Medical Technologist 078.381
Radioisotope Technologist

Prepares, administers, and measures radioactive isotopes in therapeutic, diagnostic, and tracer studies, utilizing variety of radioisotope equipment. Prepares stock solutions of radioactive materials, and calculates doses to be administered by Radiologist. Measures glandular activity, traces radioactive doses, and calculates amount of radiation, using equipment, such as Geiger Counters, electroscopes, scalers, scintillation and position scanners, and scintigrams. Calibrates equipment. Subjects patients to radiation and X-ray therapy, as prescribed by Radiologist, using such equipment as radium emanation tubes and needles, x-ray machines, and similar instruments. Executes blood volume, red cell survival, and fat absorbtion studies following standard laboratory techniques.

8. Medical Assistant 079.368

Performs following duties under direction of Physician in examination and treatment of patients. Drapes patients, prepares treatment rooms for examination, hands instruments as desired, sterilizes and cleans instruments, prepares inventory of supplies, interviews patients, may operate equipment.

*9. Inhalation Therapist 079.368
Oxygen-Therapy Equipment Technician; Oxygen-Therapy Technician

Sets up and operates various types of oxygen equipment, such as iron lungs, oxygen tents, resuscitators, and incubators to administer oxygen and other gases to patients: Observes gages and turns valves to regulate temperature and flow of gases.

*Indicates correction, revision, or addition.

Occupational Code

*10. Dental Hygienist — 078.368
Oral Hygienist, Prophylactician

Performs dental prophylactic treatments and instructs groups and individuals in care of teeth and mouth: Removes calcareous deposits, accretions and stains from teeth; swabs gums with medication after cleaning teeth. Charts conditions of decay and disease for diagnosis and treatment by Dentist. May expose and develop x-ray film. Apply medicants to aid in arresting dental decay. Prepare filling material and sterilize instruments.

11. Dental Assistant — 079.378

Performs following duties in office of Dentist. Obtains and records patient's personal information and medical history and records dental treatment rendered. Prepares patient for treatment and assists Dentist. Explains postoperative care to patient along with oral hygiene, and importance of preventive dentistry.

12. Surgical Technician — 079.378
Operating Room Technician; Surgical Orderly

Performs any combination of following tasks before and during operation. Washes, shaves, and sterilizes operative area of patient. Scrubs hands and dons cap, mask, etc. places equipment and supplies in operating room according to Surgeon. Aids operating team. May hand Surgeon instruments, hold retractors, and cut sutures, wash and sterilize used equipment and clean operating room.

*13. Food Service Supervisor — 319.138
Dietary Aid

Trains and supervises employees engaged in serving food and in maintaining cleanliness of food service area and equipment. Supervises serving of meals in dining room.

*Indicates correction, revision, or addition.

Occupational Code

Keeps records such as amount and cost of meals served and hours worked by employees. May direct preparation of food and beverages and may assist Dietician, Therapeutic in planning menus.

14. Attendent, Physical Therapy 355.878
Physical Therapy Aid

Prepares patients for treatment by Physical Therapist. Assists patients in dressing, undressing and moving about. Sets up such equipment as hydrotherapy tanks and vibrators. Places patients in position for treatment. Times length of treatment.

*15 Dental-Laboratory Technician 712.381
Dental Technician

Constructs and repairs dental applicances, according to Dentist's prescription.

Dental Technician, Crown and Bridge

Makes crowns, inlays, and pontics for fixed bridges, according to Dentist's prescription.

*16. Optician, Dispensing 713.251

Fabricates lenses to prescription specifications, fits lenses in frames, assists customer in choice of frames, and fits frames to customer: Reads prescription for frame and lens specifications. Assists customer in choosing frames by advising correct size and shape according to facial features. Measures customer for such features as bridge length and pupillary distance with ruler. Makes lenses and assembles in frame.

*Indicates correction, revision, or addition.

STATE OF MICHIGAN

FERRIS STATE COLLEGE

Big Rapids, Michigan 49307

Subject: Interview Form for Technician Need Study: Questions Concerning Training Information on Page 5.

A. If inadequacy in English:

1. Oral communication or written?
2. Difficulty in communication of ideas, directions, etc. ?
3. Or the importance of impression they make?

B. If inadequacy in writing: What kind of writing do they do? (Examples)

1. Technical reports?
2. Fill out forms?
3. Intra-firm communications?
4. Creative-type writing?
5. Persuasive writing?

C. Inadequacy in Math:

1. Is it a difficulty in applied or theoretical area?
2. Do they need refresher courses in math they have already had? Or do they need to take advanced courses?
3. What level of Math: algebra; geometry; trig; analytical geometry; is advanced algebra necessary?

D. Inadequacy in science:

1. Difficulty in application of what they know? Or lack of theoretical knowledge?
2. Physical or natural science?
3. What area of science: biology; chemistry; physics?
4. Is there difficulty with application of scientific method? Observation; analyzing; testing; etc. ?

E. Inadequacy in Industrial Relations:

1. Is there difficulty in relating to superiors or subordinates?
2. Is there difficulty in communication: oral or written?
3. Lack of knowledge of procedures to follow in supervising or carrying out directions?
4. Lack of knowledge of company policies?
5. What have been the two most significant reasons for failure to be selected for production supervisory positions?

F. Inadequacy in Technical Skills:

1. What do you believe educational institutions can do to correct this?
   a. Relating to their courses?
   b. Teaching methods (applied or theoretical)?
   c. Relating to programs (reorganization)?

2. Is the applied program and experience for the graduate of Technical schools on the post-high school level relevant to the real job situation? Is more simulated experience needed?

3. Is the technician unable to apply technical skill which he is assumed to possess? In relation to Ferris in particular--How many Ferris graduates within the firm?

This confirmation letter sent to participating firms.

Thank you for the interest expressed in the Technician Need Research Study. The participation of your firm will contribute to the results upon which to base realistic conclusions and recommendations.

Mr. James E. Cherry will be scheduled to conduct a large number of the interviews in Southeastern Michigan. Jim is a Research Associate on the staff of the Special Research Studies section here at Ferris State College. He was a transfer student from Ferris State College at Michigan State University where he received his B.S. degree and then went on to complete the M.A. requirements. Jim's major fields are industrial psychology and sociology with emphasis on the personnel function in industry.

We desire a tentative appointment for Mr. Cherry on ________________ at________. If the date and hour are not convenient, please do not hesitate to call the office in Big Rapids, Telephone No. 796-8510, Area Code 616. Mr. Cherry may be reached directly by correspondence or telephone at his Detroit address:

Mr. James E. Cherry
Apt. 11, 14972 Greenfield Road
Detroit, Michigan 48227
Telephone No. 272-3631

Jim Cherry will call you at least one week prior to a scheduled interview to reconfirm an appointment. At that time, he can discuss any questions you may have regarding the questionnaire form. We have found that the interviewer obtained much more complete information when the company representative has had the opportunity for preparation.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

Note: Similar confirmation letters sent on each staff member.

This follow-up letter sent to firms that did not respond to initial participation letter.

The attached material has been previously sent to your firm, but I now realize that is may have been improperly addressed.

Your interest in the Technician Need Research Program will provide the basis for realistic curriculum planning by Michigan educational institutions. The study has been financed by the Michigan Department of Economic Expansion and Michigan Department of Vocational Education.

Your company should benefit through the availability of more technically trained personnel. These technicians will have had more pre-service training on a post high school level. Therefore, the company's on-the-job training programs will not require as much emphasis on basics.

The information received during the interview will be treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures

Type of Firm	Number of Firms (Note 1)	Number of Employees
10	4	6,350
14	5	1,492
15	21	4,461
16	11	2,457
17	11	1,160
171	16	2,385
19	3	2,806
20	22	17,391
22	1	450
23	4	1,527
24	1	245
25	14	9,748
26	19	11,756
27	3	1,100
28	24	33,485
29	4	2,252
30	12	12,400
31	3	3,785
32	9	6,121
33	47	45,078
34	46	28,667
35	89	71,578
36	27	27,175
366	3	2,105
3679	12	1,558
3699	3	163
37(Note 2)	53	503,457
38	7	5,751
39	7	4,413
42	5	2,235
48	4	28,323
483	1	132
49	8	24,967
50	2	900
53	3	3,800
54	2	3,150
5510	8	1,069
56	1	1,600
59	1	1,400
60	6	4,488
61	1	400
63	4	4,386

continued

Type of Firm	Number of Firms (Note 1)	Number of Employees
64	1	200
73	8	2,828
806	73	50,476
8071	11	249
8072	25	428
891	43	8,233
Total Interviews	688	950,580

Note 1: The number of firms from which technician employment statistics were obtained.

Note 2: The three automobile manufacturers have been included under SIC 371. However, their divisions or plants are actually classified under SIC's 19, 23, 28, 32, 33, 34, 36, and 37.

METHOD FOR COMPUTING ESTIMATES OF TECHNICIAN NEEDS

Estimates of technician needs were computed for firms not interviewed but which met the criteria for inclusion in the study. There were 517 such firms; they had a combined employment of 209,269, excluding hospitals.

Firms were grouped by Standard Industrial Classification code and estimates were made for each technician occupational title such as: Mechanical-Engineering Technician, Mechanical Maintenance Man, Optical Technician, etc. Estimates were not made for the unclassified technician categories. Occupational titles used by the employer were grouped into the unclassified category when the job functions were not sufficiently similar to the definitions used in the study.

The total employment of firms not interviewed (in each SIC) was divided by the total employment of firms interviewed (in each SIC). The resulting rate was applied to present employment of technicians, present technician vacancies, and projected total employment of technicians for 1970 in firms interviewed. The process resulted in estimates of present employment of technicians, present technician vacancies, and total employment of technicians for 1970 in firms meeting the criteria, but not interviewed. The estimates of total employment of technicians in 1970 are reported in the appropriate sections of this report.

There was no attempt to compute technician needs for all Michigan firms. The non-random selection of firms for the study precluded making estimates of technician needs for firms which did not meet the Study criteria.

Projections were made for employment of technicians in hospitals (SIC 806) in two steps. During many of the interviews in hospitals, the interviewee did not care to make projections. Estimates were computed for hospitals that were interviewed but which did not furnish projections. In hospitals furnishing projections of technician needs for 1970, there was no apparent relationship between the total employment and the number of technicians needed.

Step 1: Each health related technician occupation was computed individually. The present employment of technicians and the present vacancies in hospitals not making projections for 1970 were combined and divided by the present employment of technicians and the present technician vacancies in hospitals making 1970 projections. The resulting rate was applied to the total projected 1970 technician employment to arrive at an estimate of the technician need in hospitals not supplying their own projections.

Step 2: Estimates of technician needs in hospitals not interviewed but meeting the selection criteria were computed by the same method as other firms not interviewed. There were 43 hospitals which met the Study criteria for inclusion but were not interviewed. These hospitals had a combined employment of 27,440. Health related technicians are employed in hospitals (SIC 806), medical laboratories (SIC 8071), and dental laboratories (SIC 8072).

EXAMPLE: Computation of Technician Needs in Firms Not Interviewed

Technician Classification: Mech. -Eng. Tech.

SIC Code	Employment in Firms Not Interviewed ÷ Employment in Firms Interviewed = Rate	Present Technician Employment in Firms Interviewed times (x) Rate = Present Technician Employment in Firms not Interviewed
35	8,212 ÷ 71,578 = .11	430 x .11 = 47
891	297 ÷ 8,233 = .03	42 x .03 = 1
SIC Code	Vacancies in Firms Interviewed times (x) Rate = Vacancies in Firms not Interviewed	Total Projected Technician Employment for 1970 in Firms Interviewed times (x) Rate - Total Projected Technician Employment for 1970 in Firms not Interviewed
35	52 x .11 = 6	649 x .11 = 71
891	17 x .03 = 1	89 x .03 = 3

Type of Firm	CORRESPONDENCE (The following firms had few or no technicians. Employment figures were obtained from Michigan Employment Security Commission data.)		TELEPHONE CONTACTS (Firms with no technicians)	
S.I.C.	Total Employment	No. of Firms	Total Employment	No. of Firms
10	361	1		
1380			160	1
1510	501	3	261	3
16			215	2
17	157	2	262	3
1710	62	1	231	2
20	351	1	1,023	3
22			586	1
23			410	1
24			390	2
25			490	2
26	1,555	2	535	3
27	504	1	3,047	2
28	296	1	609	3
30			423	1
31	187	1		
32			314	2
33	352	1	2,016	9
34	954*	3	629	3
35	757	1	560	3
36	189	1	512	1
3699			1,000	1
37	534	2	1,420	2
42	642	2		
505	230*	1		
506	165	1		
509	399	1		
53	296	1	533	1
58	929	2		
60	4,737	1		
70	297	1		
73			251	1
7310	291	1		
7390	284	1		
8910			85	1
	15,030	33	15,962	52

*Figures from 1965 Directory of Michigan Manufacturers

Appendix B

Supplementary Items - Technician Need Study

Part 1 - Supplementary Questionnaire to Hospitals

Part 2 - Participation Letter to Medical Laboratories, Preliminary Questionnaire to Medical Laboratories

Part 3 - Participation Letter to Dental Laboratories, Preliminary Questionnaire to Dental Laboratories

Part 4 -
- a. Participation Letter to Contract Construction firms (SIC 15 & 16)
- b. Participation Letter to Special Trade Contractors (SIC 17)
- c. Participation Letter to Engineering Architectural Service Firms
- d. Participation Letter to Electrical and Electronics Manufacturers (SIC 366, 3679, & 3699)
- e. Participation Letter to Retail Firms
- f. Participation Letter To Service Firms: Miscellaneous Business Services, Lodging Places, and Personnel Services.
- g. Participation Letter to Finance, Insurance, and Real Estate Firms
- h. Participation Letter to Automotive Repair Firms and Garages

FERRIS STATE COLLEGE

BIG RAPIDS, MICHIGAN
49307

Covering Letter on Follow-Up Questionnaire Sent to Hospitals

Your participation in the Technician Need Research Study has been appreciated. Mr. ___, Personnel Director, was very cooperative in supplying the information. We would appreciate your continued cooperation on additional or supplemental information desired. Mr. ___ may be able to continue with his assistance by following through on the request contained in this letter.

In the Technician Need Research Program, we have obtained most of the information from the hospitals through interviews. Currently, we are reviewing and studying the interview questionnaire reports and notes. Because of their use in many hospitals, four position titles were frequently entered on the questionnaire form during the interview. The definitions for such occupational titles were not available or were not adequately defined during the interview.

TITLE	OCCUPATIONAL CODE
Inhalation Therapist	079.368
Medical Secretary	201.368
Medical Record Technician	249.388
Food Service Supervisor (Dietary Aid)	319.138

We will appreciate a review of the definitions for the above classifications of the enclosed occupational title listings. Thereafter, please complete the supplemental questionnaire sheet and return to the address indicated.

The complete listing has been enclosed for your files. They have been revised or corrected since you previously received them. We will appreciate your interest in providing the requested information. We trust that the desired information can be furnished with a minimum expenditure of time.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

FERRIS STATE COLLEGE

BIG RAPIDS, MICHIGAN
49307

TECHNICIAN REQUIREMENTS

Subject: Supplemental sheet fot Technician Need Research Project

Occupational Title	DOT Code	Presently Employed	Would Employed Available	Estimate of January 1970 Needs
Inhalation Therapist	079.368			
*Medical Secretary	201.368			
*Medical Record Technician	249.388			
Food Service Supervisor (Dietary Aid)	319.138			

Please return to:

James D. Kelly, Project Director
Department of Administrative Studies
FERRIS STATE COLLEGE
Big Rapids, Michigan 49037

Telephone Number: Area Code 616, 796-8510

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*Note to the reader of this report:

Definitions for these classifications appear on the following page, but the other two have not been repeated. They appear on pages 163 and 164 of this report.

Occupational Code

201.368

MEDICAL SECRETARY

Prepares medical charts and reports for doctor or hospital personnel, utilizing knowledge of medical terminology. May prepare and send bills to patients and record appointments.

Preparation includes courses in anatomy, physiology, pathology, psychology, medical terminology, and clinical laboratory procedures.

NOTE: Many comments received during the Technician Need Research Study from hospital personnel revealed that preparation for medical secretary should include more technical subjects in the basic sciences. This would class the individual as a technician rather than a clerical personnel.

MEDICAL RECORD TECHNICIAN

Classifies medical records of hospital patients and compiles statistics for use in reports and surveys. Keeps daily statistical record of information, such as admissions, discharges, deaths, births, and types of treatment rendered, using records, such as admission and discharge slips and medical charts.

Works in Medical Records Administration; background includes anatomy, medical terminology, medical records science, statistics, and other related subjects.

NOTE: Many hospitals have expressed a concern for the availability of medical record personnel to work under the medical record librarian. In some cases they have employed medical secretaries for such work. The American Association of Medical Records Librarians has developed a national accreditation examination for an Accredited Record Technician.

The 1965 Health Careers Guide Book on page 160 emphasizes this as a new job classification. There are no educational institutions currently offering such a formalized program in the state of Michigan.

Example of participation letter sent to Medical Laboratories

We are currently engaged in a Technician Need Research Study, a part of which involves the health-related technologies. The study of needs for health related classifications involves classifications employed by medical laboratories. The attached information sheet will give you information on the extent of our total research project.

We desire to interview representatives of the medical laboratories falling under the Standard Industrial Classification code 8071 who employ classifications similar to occupational titles listed in the enclosed material. We have attached descriptions of duties for some of the classifications found in medical laboratories. You may have some additional ideas.

Your participation in the Technician Need Research Program should assist the medical laboratories in Michigan by insuring an adequate supply of technically trained personnel. We are confident that you realize the many advantages of pre-service training which incorporates both theory and practice. The improved occupational readiness of potential employees can result in higher productivity with a less intensive period of training following employment.

Please advise if you are interested in participating. We would appreciate the return of the enclosed information on medical laboratory classifications. It will assist us in knowing the types of occupational titles used and the number of employees. Thereafter, we can make arrangements for scheduling individual visits to the laboratory.

We shall be most grateful of your cooperation in this study. Your completion of the questionnaire will form the basis for the exchange of more specific information during the scheduled interview. The information received during the interview is treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

P.S. We do regret that requests for participation from dental laboratories (SIC code 8072) were incorrectly addressed to medical laboratories. We appreciated the notes and letters from the medical laboratory personnel who called this error to our attention.

FERRIS STATE COLLEGE

BIG RAPIDS, MICHIGAN 49307
Telephone Number: 796-8510, Area Code 616

MEDICAL LABORATORY QUESTIONNAIRE

1. Name of Medical Laboratory: ______________________________

   ____

2. Address: ______________________________

   ____

   ____

3. Number of Each Health Related Technician Classification that is Employed:

   a. Radiologic Technologist (X-Ray) ________
   b. Electrocardiograph Technician ________
   c. Registered Medical Technologist-Mt(ASCP) ________
   d. Nuclear Medical Technologist-NMT (ASCP) ________
   e. Certified Laboratory Assistant (CLA) ________
   f. Histologic Technician - HT (ASCP) ________
   g. Cytotechnologist - CT (ASCP) ________
   h. Other (List)
      (1) ________________ ________
      (2) ________________ ________
      (3) ________________ ________
      (4) ________________ ________

4. Definitions and/or description of work performed: The following definitions and/or descriptions of work performed have been excerpted from the 1965 Dictionary of Occupational Titles or descriptive literature of professional organizations.

   a. Radiologic Technologist: DOT No. 078.368
      X-Ray Technologist -

      Applies roentgen rays and radioactive substances to patients for diagnostic and therapeutic purposes: Positions patient under X-ray machine adjust immobilization devices, and affixes lead plates to protected unaffected areas. Administers drugs or chemical mixtures orally or as enemas to render organs opaque. Adjusts switches regulating length and intensity of exposure. Develops film in accordance with photographic techniques. Assists in treating diseased or affected areas of body, under supervision of Physician, by exposing area to specific concentrations of X-ray for prescribed periods of time. Prepares reports and maintains records of services rendered. Makes minor adjustments to equipment. May assist in therapy requiring application of radium or radioactive isotopes. May specialize in taking X-rays of specific areas of body.

b. Electrocardiograph Technician: DOT No. 078.368
E.K.G. Technician

Records electromotive variations in action of heart muscle, using electrocardiograph machine, to provide data for diagnosis of heart ailments: Attached electrodes to specified areas of patient's body. Turns selector switch and moves chest electrode to successive positions across chest to record electromotive variations occuring in various areas of heart muscle. Presses button to mark tracing paper to indicate position of chest electrodes. Replenishes supply of paper and ink in machine and reports malfunctions. Send tracings to Cardiologist for analysis and interpretation. May develop film. (Editors Note: Work may be performed by Medical Technologist)

c. (Registered) Medical Technologist-MT (ASCP): DOT No. 078.381
(The Dictionary definition includes C (ASCP) and M (ASCP) but it has been excluded from the definition below.)

Performs chemical, microscopic, and bacteriologic tests to provide data for use in treatment and diagnosis of disease: Obtains such body materials as urine, blood, pus, and tissue directly from patient. Cuts, stains, and mounts tissue sections for study by Pathologist. Performs blood tests and transfusions, stuides morphology of blood, and prepares vaccines and serums. Groups or types blood and crossmatches that of donor and recipient to ascertain compatibility. Determines basal metabolism rate. Engages in medical research to further control and cure disease.

d. Nuclear Medical Technologist-NMT (ASCP): DOT No. 078.381
Radioisotope Technologist

Prepares, administer, and measures radioactive isotopes in therapeutic, diagnostic, and tracer studies, utilizing variety of radioisotope equipment. Prepares stock solutions of radioactive materials and calculates amount of radiation, using equipment, such as Geiger Counters, electroscopes, scalers, scintillation and position scanners, and scintigrams. Calibrates equipment. Subjects patients to radiation and x-ray therapy, as prescribed by Radiologist, using such equipment as radium emanation tubes and needles, x-ray machines, and similar instruments. Executes blood volume, red cell survival, and fat absorption studies following standard laboratory techniques.

e. Medical-Laboratory Assistant: DOT No. 078.381
Medical Technician (Certified Laboratory Assistant-CLA)

Performs routine tests in medical laboratory for use in treatment and diagnosis of disease: Perpares tissue samples for Pathologist, takes blood samples, and prepares vaccines. Executes such laboratory tests urinalyses and blood counts, using microscopes, micrometers, and similar instruments. Makes quantitative and qualitative chemical and biological analyses of body specimens, under supervision of Medical Technologist or Pathologist. May be designated according to field of specialization as Blood Bank Technician: Cytotechnician; Hematology Technician; Serology Technician; Tissue Technician.

f. Tissue Technologist: DOT No. 078.381
(Histologic Technician-HT: ASCP)

Cuts, stains, and mounts specimens of human or animal tissue for study. Trims tissue, fixes it in formaldehyde or other fixing folution, and dehydrates it by immersion in acetone or alcohol baths. Places specimen in paraffin or imbeds it in celloidin until ready for processing. Inserts prepared tissue in microtoine and stains it to define essential features; Mounts tissue on microscope slides.

g. Cytotechnologist: DOT No. 078.281
(CT-ASCP)

Stains, mounts, and studies cells of human body to determine pathological condition: Adds various dyes and reagents to render specimens more visible, places cell smears on slide, and inserts slide under microscope. Examines specimen, and diagnoses nature and extent of disease or cellular damage. Executes variety of laboratory tests and analyses to confirm findings. Reports information to pathologist.

h. Description of work performed by other health related classifications used by the laboratory:
(1)
(2)
(3)

Example of participation letter sent to Dental laboratories.

We are currently engaged in a Technician Need Research Study, a part of which involves the health-related technologies. One of the health related classifications is dental laboratory technician. The attached information sheet will give you information on the extent of our total research project.

We desire to interview representatives of the dental laboratories employing occupational positions generally falling under the Standard Industrial Classification code 807. We have attached descriptions for individual classifications found in dental laboratories. You may have some additional ideas.

Your participation in the Technician Need Research Program should assist all dental laboratories in Michigan by insuring an adequate supply of technically trained personnel. We are confident that you realize the many advantages of pre-service training which incorporates both theory and practice. The improved occupational readiness of potential employees can result in higher productivity with a less intensive period of training.

Please advise if you are interested in participating. We would appreciate the return of the enclosed information on dental laboratory classifications. It will assist us in knowing the types of occupational titles used and the number of employees. Thereafter, we can make arrangements for scheduling individual visits to your laboratory during late June and July of this year.

We shall be most grateful for your cooperation in this study. Your completion of the preliminary questionnaire will form the basis for the exchange of information during the scheduled interview. The information received during the interview is treated as confidential.

You are probably aware that Ferris State College is initiating a program in Dental Laboratory Technology at the beginning of the Fall Term of 1966. However, the information in our research program is for the benefit of any educational institution desiring to institute such a program to meet the needs in the state of Michigan.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

PRELIMINARY QUESTIONNAIRE

1. Name of Dental Laboratory:______________________________

2. Address:____
____
____

3. Number of Employees in Laboratory:________________________

4. Number of Each Dental Laboratory Technician Classification Employed:

   a. Generalist:______________________________________
   b. Dental Laboratory Technician-Full Denture:________________
   c. Dental Laboratory Technician-Partial Denture:______________
   d. Dental Laboratory Technician-Ceramics:__________________
   e. Crown and Bridge Technician:__________________________

5. Description of Work Performed: The following types of work are those usually performed by dental laboratory technician classifications:

   a. Generalist

      (1) Full-Denture Fabrication
      (2) Partial-Denture Fabrication
      (3) Ceramics
      (4) Crown and Bridge

   b. Dental Laboratory Technician - Full-Denture

      (1) Pouring the impression, model making, and trimming.
      (2) Mounting models on articulators and arrangement of artificial teeth.
      (3) Repairing, duplicating, and relining of full dentures.
      (4) Selection, characterizing, and staining of artificial teeth.
      (5) Waxing and contouring denture bases.
      (6) Processing, curing, finishing, and polishing.

      Note: In large commercial laboratories, the full-denture technician may devote all of his time in arrangement of artificial teeth only; or his work may be restricted to any one phase of full-denture construction.

c. Dental Laboratory Technician - Partial Denture

(1) Pours impressions and trims models.
(2) Surveys models.
(3) Designs the appliance in accordance with the work authorization or prescription.
(4) Fabricates the framework in wax.
(5) Selects and reshapes teeth to be used.
(6) Sprues, invests, casts, finishes, and polishes the framework.

Note: In large commercial laboratories, the partial denture technicians will usually do only part of procedure; i.e., Numbers (2), (3), (4), and (5). Many times the finishes framework is sent to the full-denture department to have the teeth set and process and appliance.

d. Dental Laboratory Technician - Ceramics

(1) Pour models.
(2) Fabricate dies.
(3) Blend porcelain.
(4) Bake porcelain.
(5) Finish and polish.

e. Crown and Bridge Technician

(1) Pours models.
(2) Fabricates dies.
(3) Articulates models.
(4) Waxes patterns.
(5) Selects, grinds, and glazes porcelain pontics.
(6) Invests, casts, finishes, and polishes bridge work.
(7) Blinds stains and processes acrylic.
(8) Solders.

Note: In large commercial laboratories, the crown and bridge technician may do only part of the entire case; i.e., Numbers (4), (5), (7), and (8).

Example of participation letter sent to contract construction firms.

Information has been attached on a Technician Need Study which is presently in progress. In our sample of firms to be interviewed, we have included a number of construction firms where the first two digits of the SIC code are 15 and 16.

The principal purpose of this inquiry is related to the Technician Need Study for the State of Michigan. However, you may be interested in the fact that Ferris State College will have a construction technology course commencing in the fall quarter of 1966.

We would appreciate your interest in this survey of technician needs. The participation of your firm is important to learn the present or projected requirements for personnel with post-high school education. Our survey does not include the baccalaureate degree personnel level. We would appreciate a response on your firm's interest in participating.

Please advise if you will participate and designate the individual to be contacted. Normally, we would need one to two hours interview time with your representative. We would be most grateful for your cooperation in this study. The information exchanged during the interview will be treated as confidential.

The enclosed interview questionnaire form may be more extensive than required for the interview with your firm. However, it will provide you with a concept of the scope of our study. You will probably be most interested in the classifications related to drafting and designing and possible cost estimator.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures

Example of participation letter sent to special trade contractors

Information has been attached on a Technician Need Study which is presently in progress. In our sample of firms to be interviewed, we have included a number of construction firms where the SIC code is 17.

The principal purpose of this inquiry is related to the Technician Need Study for the State of Michigan. However, you may be interested in the fact that Ferris State College will have a construction technology course commencing in the fall quarter of 1966.

We would appreciate your interest in this survey of technician needs. The participation of your firm is important to learn the present or projected requirements for personnel with post-high school education. Our survey does not include the baccalaureate degree personnel level. We would appreciate a response on your firm's interest in participating.

Please advise if you will participate and designate the individual to be contacted. Normally, we would need one to two hours interview time with your representative. We would be most grateful for your cooperation in this study. The information exchanged during the interview will be treated as confidential.

The enclosed interview questionnaire form may be more extensive than required for the interview with your firm. However, it will provide you with a concept of the scope of our study. You will probably be most interested in the classifications related to air-conditioning mechanics and electrical technicians.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures

Example of participation letter sent to Engineering and Architectural Service firms.

We are currently engaged in a Technician Need Research Study, a part of which involves classifications that would be employed by firms furnishing engineering and/or architectural services. The attached information sheet may assist in familiarizing you on the extent of the total research project.

We desire to interview a representative of your firm for the information. The Standard Industrial Classification code is 891 for most firms of your type in the category of interest to our study.

Your participation in the Technician Need Research Study should benefit industry in the state through the availability of more technically trained personnel. The technicians will have had more preparatory training through a post-high school, pre-service educational program. Such training will provide more occupational readiness and the company's on-the-job training programs will not require intensive emphasis on basic subject matter. In addition, the results from the research project can assist Michigan educational institutions with more meaningful curriculum planning.

Please advise us if you will participate and designate the individual that should be contacted. Normally, we would need from one to two hours interview time with your representative.

We shall be most grateful for your cooperation in this study. The information exchanged during the interview will be treated as confidential. The enclosed interview questionnaire form provides you with the opportunity to review the types of information we are seeking, especially in the drafting and design related technologies.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures (3)

4

Example of participation letter sent to Electrical and Electronics Manufacturers.

We are currently engaged in a Technician Need Research Program. Ferris State College desires your participation in our research project. I have attached an information sheet which will provide you with background information on the Study.

We desire to interview representatives from firms manufacturing communication equipment, electronic components, and electrical products, Standard Industrial Classification code numbers 366, 3679, and 3699. We are attempting to interview all such firms in the state of Michigan.

Your participation in the Technician Need Research Program should benefit industry in the state through the availability of more technically trained personnel. The technicians will have had more preparatory training through a post-high school educational, pre-service educational program. Such training will provide more occupational readiness and the company's on-the-job training programs will not require intensive emphasis on basic subject matter. In addition, the results from the research project can assist Michigan educational institutions with more meaningful curriculum planning.

Please advise us if you will participate and designate the individual that should be contacted. Normally, we would need from one and one-half to two hours interview time with your representative.

We shall be most grateful for your cooperation in this study. The information exchanged during the interview will be treated as confidential. The enclosed interview questionnaire form provides you with the opportunity to review the types of information we are seeking, especially in the electrical and electronic related technologies.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures (3)

Example of particiaption letter sent to Retail firms.

Your cooperation is desired for the success of a research project that has been initiated by Ferris State College. The attached information sheet provides the background information on the Technician Need Research Program.

We desire an expression of interest on your participation. We would need interview time from you or your assistant. The interviews normally take from one and one-half to three hours, depending upon the advance preparation of the company. The enclosed interview questionnaire form provides you with the opportunity to prepare prior to the scheduled interview with a member of our Research Staff. All arrangements to obtain the information are made in advance through this office and confirmed by the research staff member assigned to conduct the interview.

In the retail trade, we are interested in employers with 250 or more employees. We have enclosed the complete questionnaire form and all occupational titles with which we are concerned in the survey. Your interest may be only clerical technicians, commercial art (illustrators), and junior programmers, plus a staff nurse in addition to the electrical related and others used in building maintenance. However, we have sent all occupational title definitions to provide you with more information on the total research project.

Your interest in the Technician Need Research Program should benefit you and other retail merchants by assuring a supply of those technician classifications in which you have needs. The technically trained personnel which you employ, that have less than the baccalaureate degree, would benefit from post-high school, pre-service educational programs. Hence, the retail organization's training program will require less emphasis on basics. In addition, the results from the research project should assist Michigan educational institutions with more meaningful curriculum planning.

We shall be extremely grateful for your cooperation in this project. The information given during the interview will be treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

Example of participation letter sent to service firms: Miscellaneous Business Services, Lodging places, and Personnel Services

Your cooperation is desired for the success of a research project that has been initiated by Ferris State College. The attached information sheet provides the background information on the Technician Need Research Study. We desire to have participation by firms in the Services category, specifically lodging places, personal services, and miscellaneous business services, of the Standard Industrial Classification code number system.

We desire an expression of interest on your participation. Interview time is desired from you or your representative of your Personnel Department. The interviews normally take from one and one-half to two hours, depending upon the advance preparation of the company.

The enclosed interview questionnaire form provides you with the opportunity to prepare prior to the scheduled interview with the member of our Research Staff. Arrangements to obtain the information are made in advance through this office and confirmed by the research staff member assigned to conduct the interview.

Your participation in the Technician Need Research Study should benefit industry in the state through the availability of more technically trained personnel. The technicians will have had more preparatory training through a post-high school, vocational-technical educational program. The results from the research project can assist Michigan educational institutions with more meaningful curriculum planning.

We realize that your type of firm does not employ many of the classifications listed. However, at the time of the interview the research staff member will have a copy of the 1965 Dictionary of Occupational Titles. This will enable him to add position titles to the list on a consistent basis.

We shall be extremely grateful for your cooperation in this project. The information given during the interview will be treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem
Enclosures

Example of participation letter sent to Finance, Insurance and Real Estate firms.

Your cooperation is desired for the success of a research project that has been initiated by Ferris State College. The attached information sheet provides the background information on the Technician Need Research Study. We desire to have participation by firms in the Finance, Insurance, and Real Estate categories of the Standard Industrial Classification code numbering system.

We desire an expression of interest on your participation. Interview time is desired from you or the representative of your Pensonnel Department. The interviews normally take from one and one-half to two hours, depending upon the advance preparation of the company.

The enclosed interview questionnaire form provides you with the opportunity to prepare prior to the scheduled interview with a member of our Research Staff. Arrangements to obtain the information are made in advance through this office and confirmed by the research staff member assigned to conduct the interview.

Your participation in the Technician Need Research Study should benefit industry in the state through the availability of more technically trained personnel. The technicians will have had more preparatory training through a post-high school, vocational-technical educational program. The results from the research project can assist Michigan educational institutions with more meaningful curriculum planning.

We realize that your type of firm does not employ many of the classifications listed. However, at the time of the interview, the research staff member will have a copy of the 1965 Dictionary of Occupational Titles. This will enable him to add position titles to the list on a consistent basis.

We shall be extremely grateful for your cooperation in this project. The information given during the interview will be treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures (3)

Example of participation letter sent to Automotive Repair firms and garages.

Your cooperation is desired for the success of a research project that has been initiated by Ferris State College. The attached information sheet provides the background information on the Technician Need Research Study. We desire to have participation by firms in the Service category, specifically automobile repair, services, and garages of Standard Industrial Classification code numbering system.

We desire an expression of interest on your participation. Interview time is desired from you or the representative of your Personnel Department. The interviews normally take from one and one-half to two hours, depending upon the advance preparation of the company.

The enclosed interview questionnaire form provides you with the opportunity to prepare prior to the scheduled interview with a member of our Research Staff. Arrangements to obtain the information are made in advance through this office and confirmed by the research staff member assigned to conduct the interview.

Your participation in the Technician Need Research Study should benefit industry in the state through the availability of more technically trained personnel. The technicians will have had more preparatory training through a post-high school, vocational-technical educational program. The results from the research project can assist Michigan educational institutions with more meaningful curriculum planning.

We realize that your type of firm does not employ many of the classifications listed. However, at the time of the interview the research staff member will have a copy of the 1965 Dictionary of Occupational Titles. This will enable him to add position titles to the list on a consistent basis.

We shall be extremely grateful for your cooperation in this project. The information given during the interview will be treated as confidential.

Sincerely,

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures (3)

Appendix C

Training Opportunities in Post-Secondary Institutions

Part 1 - Participation Letter to Schools

Part 2 - Post-Secondary Educational Institutions

Example of participation letter sent to Schools

We are in the process of conducting a Technician Need Study for the State of Michigan. We desire your cooperation in a particular phase of this study. We feel that it is not only necessary to discover the areas in which Technicians are needed, but also, to learn what programs are available (within the State) to train technicians.

For the above stated reason, we would like an interview with you or your designated representative to discuss such information as: a) the programs offered by your institution, which would train technicians in the classifications listed on the attached questionnaire, b) the number of students enrolled in each program, and c) where the graduates of your programs locate--near their home towns, etc.

For your review we have enclosed a general information sheet and the questionnaire pages listing the classifications of technicians. In addition to the above purposes for the interview, we will desire other information from those educational institutions that employ technicians. We are using a criteria for inclusion of educational institutions in the study that requires a minimum number of employees for the industry category "Educational Services", Standard Industrial Classification Codes 82, 822, 824, 8242, and 829.

We will look forward to hearing from you.

Sincerely

James D. Kelly, Project Director
Department of Administrative Studies

JDK/sem

Enclosures

TRAINING OPPORTUNITIES -- POST-SECONDARY EDUCATIONAL INSTITUTIONS

The primary interest was in those educational institutions that offer post-secondary occupational programs in the sub-baccalaureate level. The programs were reviewed that related to the occupational classifications used in the Technician Need Study.

The following types of institutions were visited to obtain information on curriculum content, enrollments and the educational facilities for "hands-on" skill development:

1. Universities (Public - State)	4
2. Colleges (4 yr. Public - State)	2
3. Four-year Degree Granting (Private)	1
4. Community and/or Junior Colleges (Public)	23
5. Vocational Rehabilitation Institute (Public - State)	1
6. Private Institutes (Controlled by Manufacturing Corporation)	1
7. Vocational Schools Non-Degree (Private)	7
TOTAL	39

Participating Michigan Public and Non-Public Schools

Alpena Community College
Bay deNoc Community College
Flint Community Junior College
Henry Ford Community College
Gogebic Community College
Grand Rapids Junior College
Ferris State College
Highland Park Junior College
Jackson Community College
Lake Michigan College
Lansing Community College
Macomb County Community College
Michigan Rehabilitation Institute
Michigan Technological University
Lake Superior State College
Monroe County Community College
Muskegon County Community College
Montcalm Community College
North Central Michigan College
Northern Michigan University
Oakland County Community College
Port Huron Junior College
Schoolcraft College
Delta College
Washtenaw Community College
Southwestern Michigan College
Northwestern Michigan College
Western Michigan University
Eastern Michigan University
Lawrence Institute of Technology
Chrysler Institute
Detroit Time-Study School
Industrial Training School, Inc.
Automation Institute
Electronics Institute of Technology
Detroit College of Applied Science
Carnegie Institute of Detroit
R. E. T. S. Electronic School

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